Perceptions, motivations and behaviours towards 'research impact': a cross-disciplinary perspective

Perceptions, Motivations and Behaviours Towards ‘Research Impact’: A Cross-Disciplinary Perspective

By

Lesley T. Chikoore

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Abstract

In recent years, the UK higher education sector has seen notable policy changes with regard to how research is funded, disseminated and evaluated. Important amongst these changes is the emphasis that policy makers have placed on disseminating peer-reviewed scholarly journal articles via Open Access (OA) publishing routes e.g. OA journals or OA repositories. Through the Open Science agenda there have also been a number of initiatives to promote the dissemination of other types of output that have not traditionally been made publicly available via the scholarly communication system, such as data, workflows and methodologies. The UK Research Excellence Framework (REF) 2014 introduced social/economic impact of research as an evaluation measure. This has been a significant policy shift away from academic impact being the sole measure of impact and has arguably raised the profile of public engagement activities (although it should be noted that public engagement is not equivalent to social/economic impact, but is an important pathway to realising such impact). This exploratory study sought to investigate the extent to which these recent policy changes are aligned with researchers' publication, dissemination and public engagement practices across different disciplines. Furthermore, it sought to identify the perceptions and attitudes of researchers towards the concept of social/economic impact.

The study adopted a mixed-methods approach consisting of a questionnaire-based survey and semi-structured interviews with researchers from a broad range of disciplines across the physical, health, engineering, social sciences, and arts and humanities across fifteen UK universities. The work of Becher (1987) and Becher & Trowler (2001) on disciplinary classification was used as an explanatory framework to understand disciplinary differences.

The study found evidence of a lack of awareness of the principle of OA by some researchers across all disciplines; and that researchers, in the main, are not sharing their research data, therefore only the few who are doing so are realising the benefits that have been championed in research funders' policies. Moreover, the study uncovered that due to the increased emphasis of 'impact' in research evaluation, conflicting goals between researchers and academic leaders exist. The study found that researchers, particularly from Applied and Interdisciplinary (as opposed to Pure) disciplinary groups felt that research outputs such as articles published in practitioner journals were most appropriate in targeting and making research more accessible to practitioners, than prestigious peer-reviewed scholarly journal articles.

The thesis argues that there is still more to learn about what ‘impact’ means to researchers and how it might be measured. The thesis makes an overall contribution to knowledge on a general level by providing greater understanding of how researchers have responded to the ‘impact agenda’. On a more specific level, the thesis identifies the effect of the ‘impact agenda’ on academic autonomy, and situates this in different disciplinary contexts. It identifies that it is not only researchers from Pure disciplines who feel disadvantaged by the ‘impact agenda’, but also those from Interdisciplinary and Applied groups who feel an encroachment on their academic autonomy, particularly in selecting channels to disseminate their research and in selecting the relevant audiences they wish to engage with. Implications of the study’s findings on researchers, higher education institutions and research funders are highlighted and recommendations to researchers, academic leaders and research funders are given.

Keywords: *Open Access, Open Science, Public Engagement, Research data, Research dissemination, Research evaluation mechanisms, Research Excellence Framework, REF*

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Table of Contents

List of Figures

List of Tables

List of Appendices

List of Abbreviations

AHRC	Arts & Humanities Research Council
ANZSRC	Australian and New Zealand Standard Research Classification
APC	Article Processing Charges
BOAI	Budapest Open Access Initiative
CC	Creative Commons
CUDOs	Communism, Universalism, Disinterestedness, Organised Scepticism
DOAJ	Directory of Open Access Journals
ESRC	Economic & Social Research Council
HEI	Higher Education Institution
HERG	Health Economics Research Group
HESA	Higher Education Statistics Agency
IOP	Institute of Physics
IR	Institutional Repository
ISI	Institute of Scientific Information
JISC	Joint Information Systems Committee
LSE	London School of Economics
MRC	Medical Research Council
NCCPE	National Centre for Co-ordination of Public Engagement
NEA	National Endowment of the Arts
NESLI	National Electronic Site Licence Initiative
NIH	National Institutes of Health
NSF	National Science Foundation
OA	Open Access
OAI	Open Access Initiative
OECD	Organisation of Economic Co-operation & Development
OS	Open Science
OSS	Open Source Software
PLoS	Public Library of Science
PMC	PubMed Central
PMH	Protocol for Metadata Harvesting
QALYs	Quality-Adjusted Life Years
RAE	Research Assessment Exercise
RCUK	Research Councils United Kingdom
REF	Research Excellence Framework
RePec	Research Papers in Economics
RIN	Research Information Network
SCI	Science Citation Index
SIIF	Science and Innovation Investment Framework
SPARC	Scholarly Publishing & Academic Resources Coalition
SSHRC	Social Sciences & Humanities Research Council
STEM	Science, Technology, Engineering & Medicine
STM	Science Technology & Medicine
UoA	Units of Assessment

Publications

The study presented in this thesis has led to the following article being published in the journal, *Higher Education Quarterly*:

Chikoore, L., Probets, S., Fry, J. & Creaser, C. (2016). How are UK academics engaging the public with their research? A cross-disciplinary perspective. *Higher Education Quarterly*, 70(2), pp.145-169, http://dx.doi.org/10.1111/hequ.12088

Chapter 1: INTRODUCTION

1.1. Research context and research problem

Every 5-7 years UK academics have their research activities evaluated based on certain criteria (explained below). The rationale behind this evaluation, as articulated by the Higher Education Funding Council for England (2011) is based on three primary purposes: to inform *allocation* of research funding to universities; to provide *accountability* for public investment in research; and to provide *benchmarking* information and establish reputational yardsticks. Between 1986 and 2008, in a programme called the Research Assessment Exercise (RAE), three broad criteria were used for research evaluation: research output, esteem indicators and research environments. *Output* was assessed on the originality, significance and rigour of four publications submitted by each returned member of staff. The research *environment* criterion was used to evaluate a department's research achievements, such as research income and doctoral degrees awarded; and *esteem* indicators, for evaluating academic activities such as journal editing, visiting professorships, and translation of work into foreign languages (HEFCE, 2006a).

In 2004, the UK government published the *Science and Innovation Investment Framework (SIIF 2004-2014)*, setting out its vision on the need to apply research beyond the academic community in order to drive economic growth (HMT, DfES & DTI, 2004, p.5). This initiative, together with others including the *Warry Report* (2006) and the *Sainsbury Review* (2007) led to the HEFCE publishing guidelines emphasising the need to demonstrate economic and societal benefits gained from research (HEFCE, 2008, p.4). These initiatives collectively culminated in plans for the inclusion of 'socio-economic impact' of research as one of the criteria for research evaluation in the RAE's successor - the Research Excellence Framework (REF) 2014.

HEFCE (2011a, p.48) defines socio-economic impact as "*an effect on, change or benefit to the economy, society, culture, public policy or services, health, the* *environment or quality of life, beyond academia*." The socio-economic impact criterion was allocated a weighting of 20 per cent alongside two other criteria, research output (65 per cent) and research environment (15 per cent) for REF 2014. For REF evaluation purposes, HEFCE (2011b, p.3) used the terms 'reach' (how *widely* the research was felt) and 'significance' (how much *difference* it made to beneficiaries) to define socio-economic impact. HEFCE (2011b) used these terms as they sought to distinguish the two concepts of dissemination and impact - in that, while dissemination can lead to 'reach', it, on its own cannot lead to impact as defined by HEFCE if there is no evidence of how much difference (through dissemination) that research has made to beneficiaries; in other words, the 'significance' of that research.

The term 'research impact', has been used to describe both research that has influences on actors or organisations *within* the academic community (academic impact), and that which has influences on actors or organisations *outside* the academic community i.e. business, government or civil society (socio-economic impact) (LSE Policy Group, 2011, p.21). Academics have voiced their concerns with regards to the evaluation of socio-economic impact particularly for REF purposes. Some have argued that there is an increasing encroachment on their "academic autonomy" (McNay, 2007; Donovan, 2007; Ovseiko, Oancea & Buchan, 2012), particularly those who wish to conduct basic (or 'blue skies') research. Moreover, there is also the issue of time lag and attribution, i.e. the accuracy with which impacts can be traced back to a particular research project, and the length of time it takes before impacts are realised (Levitt *et al*. 2010; Bell, Shaw & Boaz, 2011).

Research impact is a particularly important concept in academia. Research evaluation mechanisms such as the UK's REF partly determine the allocation of public funds to UK universities (the other part of public funds is sourced from the seven UK Research Councils by means of competitive bids for research projects). It is logical to assume then, that institutions would want to maximise the impact of their research outputs for reputational and funding purposes; and academics themselves would also want to maximise the impact of their research, as prestige and promotion prospects partly depend on these research evaluation mechanisms. One of the ways that have been suggested for improving research impact is Open Access (OA).

OA is the practice of making mainly peer-reviewed scholarly literature freely available online, thereby removing the need for readers to pay to get access to scholarly literature. It has been argued in many publications that OA increases the citation counts of articles, therefore enhancing the academic impact of a scholar (Antelman, 2004; Norris, Oppenheim & Rowland, 2008; Gargouri *et al*. 2010). In view of this argument, many universities have sought to influence the publishing behaviour of academics by enforcing OA mandates, so as to ensure that journal articles, and a range of other research outputs such as conference proceedings, book chapters and theses are openly available in institutional repositories.

Although advocacy for OA continues, there is also now growing support (Boulton, 2012, Royal Society; 2012) for making the accompanying data, workflows, methods etc. *as well as* peer reviewed scholarly literature openly available (known as *Open science*). Some scholars, Piwowar & Chapman, (2008); Vandewalle (2012), for example, have argued that papers that are published with associated data (either published with the paper, or available through a link elsewhere on the web) accrue more citations than those that are only openly available, but without the data. The Open science (OS) literature has largely concentrated on the motivators and barriers to sharing data (Wicherts, Bakker & Molenaar, 2011; Simmons, Nelson & Simohnson, 2011; Krumholz, 2012). While attempts at investigating the citation impact of OS have been made, as identified in Piwowar & Chapman (2008) and Vandewale (2012) above; the notion of the influence of OS on the research impact of researchers, both as creators and users of data, has remained under-explored. Some studies, for example RIN (2008); Youngseek & Stanton (2012) have gone as far as identifying “potential benefits”, such as recognition from research funders to data creators for sharing their data, and opportunities for co-authorship of papers due to sharing of data. An investigation is required to assess whether these “potential benefits” are being realised as actual benefits, and what the role is of openly available data, software etc. in achieving research that has an impact.

The research considers the closely related phenomena of open access, open science and research impact, and will focus on aspects of these phenomena such as the role of openly available data in achieving academic impact; what does 'research impact' mean to academics in different disciplinary contexts, and the initiatives academics in different disciplines are taking to maximise the impacts of their research both within and beyond the academic community. In the context of the Finch Report (2012), which heavily influenced the UK government's policy on OA to scholarly literature, the 'Climategate' scandal (Dellingpole, 2009), and the Royal Society (2012) report, which have all called for open availability of research data; together with the "impact" criterion for evaluating research submitted for REF 2014 – open access, open science and research impact are highly topical and have undergone significant changes in recent years. A more recent driver, is HEFCE's (2014) OA policy which stipulates that in order to be eligible for the next REF journal articles and conference proceedings need to be uploaded on OA channels such as institutional repositories and subject-based repositories.

Despite the increased emphasis on metrics driven research evaluation (Wilsdon *et al*., 2015) the study does not focus on the relationship between research dissemination practices and research impact through the lens of bibliometrics (i.e. citation counts etc.) as this area has been extensively covered in the existing literature. Rather, the focus is on accounts given by researchers from a broad range of disciplines across the physical, health, engineering, social sciences, and arts and humanities across fifteen UK universities (through a questionnaire-based survey and semi-structured interviews) on their publication and dissemination practices, and their attitudes towards research evaluation mechanisms such as the REF2014. The end-goal of this exploratory study is to provide a better understanding of researchers' attitudes towards the "impact agenda" (Watermeyer, 2011, p.394) by considering policies related to research impact, open access and open science in the context of practice, and noting the wider implications on researchers themselves, academic leaders, research funders and the non-academic community.

To achieve this, the study adopts a mixed-methods approach consisting of an online survey questionnaire (260 respondents) and twenty-four semi-structured interviews with research-active staff from a broad range of disciplines across the physical, health, engineering, social sciences, and arts and humanities across fifteen UK universities. The work of Becher (1987) and Becher & Trowler (2001) on disciplinary classification was used as an explanatory framework to understand disciplinary differences.

1.2. Research Questions

The research problem identified above has been addressed by investigating the following three research questions, with each research question further expanded by sub-research questions.

Research Question 1:

What are the types of research outputs produced by researchers in different disciplines, what are the channels used to disseminate them, and who are the types of intended audiences?

1a) What are the number and types of research outputs (e.g. journal articles, conference papers, books, book chapters, performances, programme reports etc.) researchers have produced within the REF period 2008-2013?

1b) What are the channels researchers have used to disseminate these outputs; for example, are they using traditional channels such as journals, or other non-traditional channels such as social media and open access repositories?

1c) What are the types of public engagement activities (e.g. public presentations/demonstrations, media appearances etc.) researchers have undertaken in relation to the dissemination of their research.

The rationale behind Research Question 1 was establishing which research outputs academics valued. Also, since academics are required to submit only four outputs for the REF, what is the mix of the other non-submitted outputs produced within this period? There is evidence (Jones et al. 2001; Turner et al. 2005; Papas & Williams, 2011) that, for example, outputs such as research reports and field reports are valued by academics in disciplines such as archaeology and clinical research, therefore, it would be interesting to compare which outputs are valued by researchers in the different disciplines. Closely related to this is the question *of who are the intended audiences for these outputs? For example, are clinical researchers producing research reports for use within the academic community, by health practitioners or by policy-makers? Likewise, are field reports produced by archaeologists for example, intended for use by others within a project group or for curators and exhibitors? Another line of enquiry is what efforts are being made to make these outputs openly available, are they using open access journals, repositories, project websites etc. and are they also using other channels such as social media to communicate their research?*

Research Question 2

What role does sharing/using openly available research data play in achieving research impact in different disciplines?

2a) What are the channels (i.e. personal websites, project websites, journal websites, data repositories, open access repositories etc.) used by researchers to disseminate their data, workflows, software and methods (in other words, research by-products)?

2b) In what ways, and to what extent have these research by-products been re-used?

2c) Has researchers' (re)use of openly available data, workflows, software and methods had impact of, for example, increasing their evidence base, increasing their productivity, or some other impact on research outcomes?

2d) What benefits (if any) have been realised by researchers as a result of sharing research data, workflows, software and methods etc. For example, have they been invited for collaborative work or to present at prestigious conferences, media interviews or public talks?

Research Question 2 is primarily concerned with investigating research impact from the point of view of researchers as both data creators and data users. It investigates for example - who is the intended audience for this data; is this data being kept for personal use, for project team members, for all academics, for the business community or for policy-makers? What benefits are researchers realising as a result of sharing or using openly available research data.

Research Question 3

What are researchers' attitudes towards the current methods and frameworks used for evaluating research impact in their disciplines?

3a) What are the proposed frameworks and methods identified in the literature for evaluating research impact across different disciplines?

3b) What are the methods and frameworks researchers think might be most suitable for capturing the impacts of research in their disciplines?

3c) Are there alternative frameworks and methods that can be used for capturing the impacts of research in different disciplines (as categorised by Becher's (1987) typology of disciplines)?

Research Question 3 is focused on investigating researchers' attitudes and opinions towards research impact evaluation. It probes what 'research impact' means to researchers in different disciplinary contexts, and what indicators they consider might both be appropriate and effective in demonstrating their research impacts.

1.3. Thesis Outline

The following chapter (*Chapter 2*) presents a state of the art review of the published literature, related to changes in scholarly communication, policy shifts in relation to OA, OS and impact, and frameworks around impact. *Chapter 3* describes the methodology adopted for the study and justification for the two data collection tools selected - semi-structured interviews and questionnaire-based survey. Following this, *Chapter 4* describes how the questionnaire-based survey was administered and presents the results and analyses of the quantitative data. *Chapter 5* describes how the semi-structured interviews were administered and then presents the results and analyses of the qualitative data. *Chapter 6* integrates the findings from Chapter 4 and Chapter 5, relating this with the theory from the literature. The thesis then concludes with *Chapter 7* which highlights key findings, contribution to knowledge, limitations of the study and possible avenues of future research.

Chapter 2: LITERATURE REVIEW

The literature review is structured in the following way; firstly, it explores the developments in scholarly publishing, the background of open access, and then discusses the case for open science. Thereafter, it discusses the factors that influence scholarly dissemination and publishing behaviour before finally discussing the concept of research impact and the increasing importance of undertaking research that makes an impact.

2.1. DEVELOPMENTS IN SCHOLARLY COMMUNICATIONS

2.1.1. Introduction

The aim of this introductory section of the literature review is to look at developments in scholarly publishing and the means through which scholarly literature is made available. A description is made of the origins of the journal as a medium for formal scholarly communication, and how it evolved in adding different functions, such as the registration of ownership of ideas. Following this, the idea of free or 'Open' Access (OA) to research literature is discussed, and the drivers for OA are discussed; these are categorised into: the serials crisis (economic driver), technological and cultural drivers, and social and policy drivers.

2.1.2. Early publishing and the evolution of the journal

The research journal emerged in the mid-17th century as a form of scholarly communication after a select group of scholars (who later developed into learned societies – the first being the Royal Society) met to discuss highly contentious issues such as politics and theology (Meadows, 1998, p.7). In these groups, referred to by De Solla Price (1969, p.85) as "invisible colleges", initial communication was mainly informal, either through meetings or through private letters. Scholars communicated by letter to gain an appreciative audience of their work and to keep informed of work being done elsewhere by others (De Solla Price, 1986, p.119). As the volume of letters increased, the need grew to establish an efficient and formal 'publishing programme' in the form of a journal. This publishing programme marked the formalisation of the scholarly communication process and satisfied the desires of those members who wished to make their work public (Meadows, 1998, p.9). It also allowed non-members access to societies' work and provided a record that could be passed to succeeding scholars (Meadows 1998, p. 9).

Over time journals have acquired additional functions. In the 18th century they became a medium for registering ownership of ideas and inventions (Shauder, 1994, p.75), in the 19th century a journal article became a mechanism to get approval for a research idea or finding - and hence became a key indicator of a researcher's professional status. Some of these functions relied on one of the key features of academic journals, that of maintaining standards of quality through 'peer review' (Shauder, 1994, p.83). Peer review is defined as;

> "*the evaluation of scientific research findings or proposals, for competence, significance and originality, by qualified experts who research and submit work for publication in the same field (peers)"* (Brown, 2004, p.7).

Peer review is a hugely important aspect of scholarly communication, as until the beginning of the 19th century, scientific theory was thought to be 'infallible knowledge', and by the 20th century this view was replaced by that of the need of scientific theory to be 'well-tested' (Laudan, 1984, p.83). Peer review provided a formal opportunity to test and verify scientific work, through a process of detection and subsequent correction of errors or flaws in logic prior to the publication of an article (Benos *et al*. 2007, p.145). Despite concerns about bias, fairness and unnecessary delay (Benos *et al.* 2007, p.145), the peer review's principle of quality control has endured to this day.

As academics and researchers realised the value of journals as indicators of esteem and quality, their need to publish increased. Consequently the number of peer-reviewed academic journal titles being published grew throughout the 20th century. Mabe & Amin (2001, p.153) for example, calculated the number of peer-reviewed academic journals to have increased by almost 11 000 between 1900 and 1996. To enable researchers to keep abreast with the increasing number of published articles related to their domain, abstracting and indexing services became increasingly popular (Lougee, 2000). The first of these indexing services, called the Shepard's Citation Index had been used in the US since the 19th century in the legal profession as listings for tracking individual court cases (Garfield, 1955). However, this service was not available for journal papers until 1955 when Eugene Garfield, a linguistics scholar suggested that with the increasing number of journal articles, there was need of having a system that would allow authors to identify discussions of past papers (Garfield, 1955). Following this, the first citation index for tracking scholarly literature, the Science Citation Index (SCI) was launched in 1960 by the Institute of Scientific Information's (ISI), an organisation founded by Eugene Garfield. The SCI enabled one to trace citations from science journals, and an "impact factor" was devised by Garfield and Irving H. Sher to evaluate the significance of a particular journal and its impact on the literature and thinking of the period (Garfield, 2001). The impact factor can be calculated by dividing the number of current year citations to articles published in the journal in the previous 2 years, by the total number of articles published by the journal in the previous 2 years (Garfield, 1994) – it is in effect a average number of citations received per paper published by the journal over a two year period.

The journal impact factor became more important than an individual author's impact factor as it was the location of the articles in a distinguished journal, not the individual articles themselves that helped in "branding" the author by linking his/her name and work to that journal (Thorrin, 2003, p.4). This had the effect of researchers seeking visibility, prestige, authority, and improved institutional ranking by publishing in "elite" journals with high impact factors (Guedon, 2001). As will be seen in further sections of this literature review, the concept of impact factor is significant not only in its role in contributing to the rise in journal prices but also as an influence on how researchers behave when producing and disseminating scholarly literature.

2.1.3. Post war publishing and the 'serials crisis'

Scholarly publishing changed to a large extent after World War II. Collaboration became a defining feature of 'big science' (Cronin, 2001, p.60). Major scientific challenges across various disciplines; for example in aerospace engineering (moon exploration), nuclear physics (splitting the atom) and in biomedical sciences (mapping the human genome) typically required collaboration of scientists across disciplines and enormous levels of funding (Cronin, 2001, p.60). Soon after World War II, in the US, the federal government followed the principle that it had a responsibility to foster and fund scientific research, and that universities should conduct most of the scientific research (Lockemann, 2004, p.146). Therefore, allocation of block grants to universities using formulas became common practice (Geuna, 2001, p.616). The case for the need for public funds to fund research was an economic one, based on the non-excludability and non-rival properties of information. As a “public good”, consumption of information by one individual does not reduce the availability of information to others (non-rivalry); moreover, it is not possible to exclude non-paying consumers (non-excludability). A combination of these properties made private investment alone insufficient to fund research (Nelson, 1959, p.298).

Well into the 20th century, editors and publishers of scholarly journals recuperated costs only; but as ISI began defining “core journals” from citation counts, commercial publishers sought to gain control over these lucrative titles (Guedon, 2001). As SCI data became integral to the prestige of journals, libraries had no choice but to purchase the core journals (Thorrin, 2003, p.5). The result of this was the “serials crisis”; which describes the unusual price rises of serials, well above inflation which began in the early 1970s. Guedon (2001) argues that the time period between 1960, when the SCI was introduced and the early 1970s enabled publishers to adjust to the economic implications of the emergence of the core journals and to implement new commercial strategies. The commercial opportunities provided by the core journals allowed the scholarly publishing market to take the form of an oligopoly (Bergstrom, 2001). In this oligopoly, big commercial publishers were able to coordinate their actions in the market to an equilibrium price; therefore if any individual publisher changed its action this would have had detrimental effect on its profit margins (Bergstrom, 2001).

Butler (1999) illustrates the serials crisis as shown in Figure 2-1 below:

Fig 2-1: Serial prices between 1970 and 1990 (graph sourced from Butler (1999, p.197)

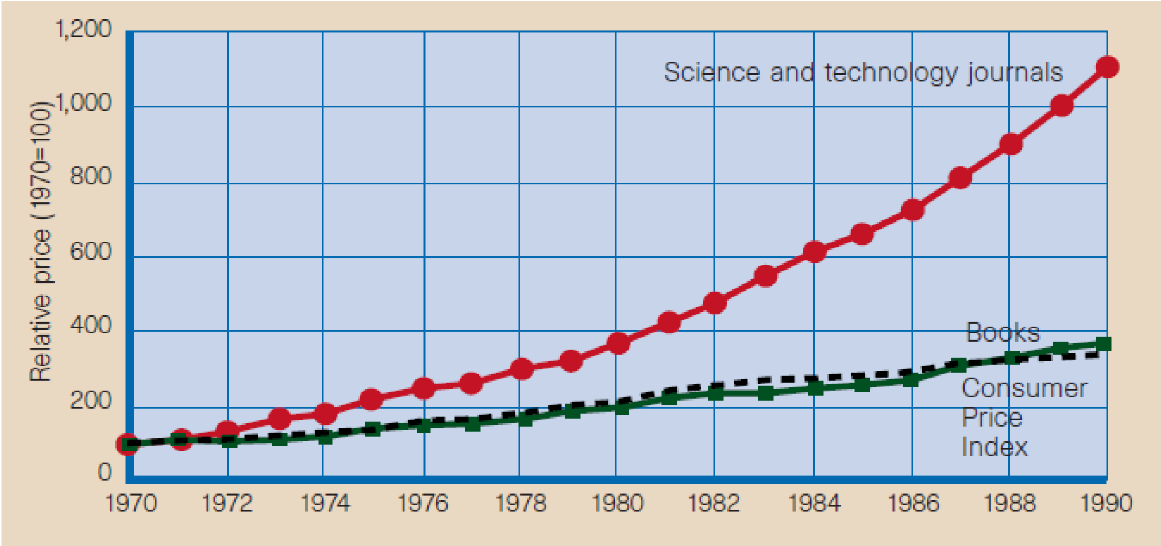


Fig 2-1 illustrates price rises of STM (science, technology and medicine) serials, well above books and inflation between 1970 and 1990. This trend has subsequently continued although at a slower rate. According to the recent statistics for US journal prices covering the years 1989-2012, Tillery (2012) found that the journal prices have consistently been above inflation, although, in 2012 the journal price rise dipped to an all-time-low of 5.8 per cent. Tillery (2012, p.2) also noted that the journal price increases (compared to inflation) were even greater in other countries, as the average price increase of non-US-based journals surpassed US-based titles in 2012.

The serials crisis can be attributed to two main reasons. Firstly, serials do not possess the same 'price elasticity' that other commodities have (Guedon, 2001; Lawal, 2002a);

"In economics terms this means that price-elasticity is low, in other words readers will not normally be much influenced by price in their decision whether or not to read a particular article. Demand is relatively unresponsive to price. A primary reason for this is that journals are not close substitutes for each other... A specialized journal thus acquires a significant amount of monopoly power. Readers are not able to find alternative sources." (Wellcome Trust, 2003, p.15).

Secondly, as noted by Anderson (2008), STM disciplines are very journal-dependent when it comes to keeping up in their field, furthering professional research, and getting the research published. This dependency creates a demand that in turn inflates subscription costs, in some cases excessively (Anderson, 2008). The notion of why STM disciplines are journal dependent compared to other disciplines in arts and humanities will be discussed later in this literature review.

2.1.3.1. Models for library subscriptions to journals

With increasing numbers of STM journals coming into circulation, and prices rising above inflation, few HEI libraries were able to maintain or increase subscriptions to their collections (Wellcome Trust, 2003, p.5). The circulation of online journals in particular, accelerated towards the mid-1990s; for example a survey by Hitchcock, Carr & Hall (1996), covering the period 1990-95, found there to be 115 full-text, peer reviewed, online STM journals. Publishers, in response to these changes introduced the concept of 'bundling' as a way of avoiding cancellations by HEI libraries which would have been a threat to publishers' livelihood (Poynder, 2012). Bundling entailed providing print and digital formats of journals as a 'bundle' i.e. subscription to several print journals could bring digital access to the entire STM journal range of that publisher (Wellcome Trust, 2003, p.5). Some of the earliest bundling deals in the UK were carried out through the Pilot Site Licence Initiative (PSLI) (1996–1998), subsidised by the Joint Information Systems Committee (JISC) and Higher Education Funding Councils (HEFCE) (Wellcome Trust, 2003, p.6). One of these bundling deals was the 'Big Deal', which was first initiated by Academic Press in 1996 and enabled libraries to buy a single "all-you-can eat" subscription for a set fee and for a set number of years (usually 3) (Poynder, 2011). The Big Deal enabled institutions to get more access not only to the print journals they had subscribed to, but all other journals from the publisher for a set fee (which in many cases equated to the current total subscription charge plus a small percentage on top). For publishers, bundling deals gave them the advantage of spreading print production costs across the subscription base of both print and digital formats of particular publications while maintaining traditional pricing models (Wellcome Trust, 2003, p.5).

As the PSLI initiative drew to a close in 1998, many issues concerning the use, access and purchase of electronic journals remained to be addressed (Bley, 1998, p.34). Therefore, in 1998, JISC launched the National Electronic Site Licence Initiative (NESLI), a service designed to promote the widespread delivery and use of electronic journals in UK academic communities through central negotiation with publishers (Woodward, 2002, p.137). Fundamental to NESLI's initial aims was "unbundling" i.e. the option of offering libraries the choice to purchase electronic journals as a separate product from the traditional print journal (Prior, 1999, p.6). National electronic journal deals were negotiated with publishers by a central negotiating body, and individual libraries, in a "loose consortia", decided whether they would opt-in to each separate deal (Woodward, 2002, p.137). With a managing agent handling aspects of the licensing process, for the publisher this model provided considerable savings in time and money in negotiating individual licences with libraries. Likewise libraries also benefitted in time and money from a consistent licence across a wide range of publishers (Woodward, 2002, p.139). However, strict contractual agreements meant libraries were unable to unsubscribe to certain journals and free up resources to use for other purposes (Thompson, 2005, p.100).

In the US, the Scholarly Publishing and Academic Resources Coalition (SPARC), an alliance of universities, research libraries, and organizations was formed in 1998, as a response to what the libraries saw as market dysfunctions in the scholarly communication system (Wellcome Trust, 2003, p.23). The initial idea was for libraries to develop a fund that would be used to fund scholarly literature publications. From that fund, contributors would create new publications on 'some model' which lowered the costs of access to journals (Frances, 2007). One of these models was a programme called BioOne which was funded by SPARC in 1999 to allow libraries access to an electronic aggregation of leading research journals in the geological, ecological and environmental sciences disciplines, with the journals then published in print by the member societies of the American Institute of Biological Sciences. In 2002, 40 journals from 29 societies became available to some 328 subscribing institutions (Frances, 2007).

2.1.4. The emergence of a new publishing channel

With all the above initiatives attempting to address (with some success) pressures on library budgets and improved access to journal literature, there was need for new channels of publication that would allow scholarly work to be widely available at little or no cost to the reader. One of them was open access (OA), which was a response to the serials crisis (Bergstrom, 2001; Thompson, 2005; Bjork *et al.* 2010). The most widely adopted definition of OA is one by the Budapest Open Access Initiative (BOAI) which was coined in 2002 by a group of stakeholders (scholars, librarians, publishers and policy makers). BOAI (2002) defined open access to scholarly outputs as:

"free availability of mainly peer-reviewed journal articles on the public internet; permitting any readers to read, download, copy, distribute, and print, provided the author is properly cited and acknowledged."

The BOAI (2002) and other initiatives that were subsequently developed such as the Bethesda Statement (2003) and the Berlin Declaration (2003) are discussed in more detail in section 2.1.6.2.

OA provided an opportunity to make scholarly literature openly available on the web through two routes: "self-archiving" (the Green route) and through publishing an article in an "OA journal" (the Gold route). The green route, gold route and OA journals are discussed later in section 2.1.6.4; but it is worth discussing here the notion of self-archiving, which refers to the practice of authors depositing their pre-prints or post-prints in digital archives that provide OA access to a variety of material (repositories) (Harnad, 2001, p.1025). Repositories are explained further in section 2.1.5.2. *Pre-prints* refer to any version of an article that has not yet gone through peer review, such as a draft circulating among colleagues or the version submitted to a journal. As described by Suber (2012, p.102), pre-prints:

"... make new work known more quickly to people in the field, creating new and earlier opportunities for citation, discussion, verification, and collaboration. How quickly? Pre-prints make new work public the minute that authors are ready to make it public ... and benefits those readers tracking new developments."

As will be seen in 2.1.5.3, the practice of disseminating pre-prints is more prevalent in particular disciplines than in others.

Post-print on the other hand, refers to any version that incorporates all changes arising from peer review. Once post-prints are copy-edited and published in a journal, they are referred to as the *final article or publisher's version*. Although, final articles are not included in Harnad's (2001) description above of self-archiving, some publishers allow them to be self-archived (Sherpa Romeo, 2013). As of September 2013, Sherpa Romeo (a site containing information and guidance on publisher policies regarding self-archiving) has a list of 325 publishers who allow self-archiving of the publisher's version.

The reaction to OA from some stakeholders was not all positive. Learned societies for example, argued that their members, who had benefited from the 'privilege' of having discounted access to reputable journals, would not have much motivation in paying membership fees when the articles would be freely available online to everyone (Kling *et al.* 2004). In other words, OA had become a threat to their so-called 'privilege'.

There was also the issue of quality control. Both commercial and learned society publishers argued that with green OA, there were no quality control procedures such as peer review;

> *"Peer review is a critical part of scientific publishing. It gives authors feedback on and validation of their analyses from other experts in their field … There is a misconception that the peer review process is provided by volunteer experts at no cost to publishers. This is simply not true. Although peer reviewers themselves are typically not paid, publishers incur considerable staff, capital, and operational costs…* (Association of American Publishers, 2006, pp.2-3).

OA advocates such as Poynder (2006) responded by stating that OA and peer review were not mutually exclusive, and that while some scholars made available their pre-prints on the internet, they did it solely for the purposes of making their research available more quickly – but not to avoid peer review. Moreover, addressing what he called common misconceptions about peer review in OA since its establishment, Suber (2009a) asserted that the OA movement was centred on making available peer-reviewed literature, the goal being "to remove access barriers, not quality filters". Suber (2009a) added that the purpose of pre-prints exchanges was to firstly give authors feedback to improve their pre-prints before they are published in peer-reviewed journals, in other words, these pre-prints were "*en-route* to peer review, *not circumventing* peer-review"; and secondly, to proclaim early findings on a particular study.

2.1.5. Technological and cultural drivers of OA

Technological developments in the internet and World Wide Web, combined with the cultural practices in particular disciplines, played an important role in driving OA.

2.1.5.1. General technological developments

Suber (2009b) notes the first strands of OA to have emerged in 1969 when the first Request for Comments titled RFC-1, published by Steve Crocker triggered a series of free, online documents posted by computer scientists on the developments of the internet. RFCs were memoranda intended to be an informal fast distribution way to share ideas with other network researchers and to help provide a record for the design of the Advanced Research Projects Agency Network (ARPAnet) – which developed to become the internet. RFCs were generated by the Internet Engineering Task Force (IETF), and then reviewed by the IETF sub-groups, various experts, and the RFC Editor before publication (Crocker, 2000). It can be deduced from this that RFCs went through a form of quality control akin to the peer review process of a conventional journal article.

Shortly after, Project Gutenberg was launched in 1971 by Michael Hart, a computer science student, with an aim of digitising cultural works in the public domain (i.e. works not covered by intellectual property rights) and making them freely available online (Lebert, 2008, p.2). Michael Hart's efforts in keying the US Declaration of Independence on a Telnet (which developed through RFCs) connection resulted in the creation of the world's first electronic book, titled eBook 1 (Lebert, 2008, p.15).

The increased uptake of the internet, and the advent of the world-wide web in the late 1980s provided opportunities for “electronic alternatives to paper based publishing” (King, 1980, p.99). An example of these electronic alternatives was Psycoloquy; a free online journal that was launched in 1989 by cognitive scientist, Stevan Harnad. This journal was launched under the principles of what Harnad (1990) described as ‘scholarly skywriting’; based on his encouragement for scholars to have discussion forums on email networks as a way of evoking debate on a particular topic and speeding up access to research. Harnad (1990) asserted that such skywriting would never be possible on print journal literature as its turnaround times were too slow.

The early 1990s marked the emergence of document formats that made it easier to communicate scholarly literature online. Adobe Acrobat’s portable document format (PDF), for example, launched in 1991 allowed page images to be transmitted and received electronically without loss of content (Hitchcock, Carr & Hall, 1996). It also allowed formatting data without noticeable image degradation and without requiring expensive software viewers (Hitchcock, Carr & Hall, 1996). However, it is the development of OA repositories that changed the way in which scholarly literature was distributed. OA repositories provided an organised database for hosting scholarly literature including journal articles and pre-prints, together with the corresponding metadata (i.e. name of author, title and year of publication etc.) allowing the outputs to be searched and retrieved.

2.1.5.2. Open access repositories

Darby *et al*. (2009, p.121) identified three types of repositories; the institutional repository, subject repository, and funder repository. The *institutional repository* (IR) is a collection of research outputs and/or associated metadata with a common link to a Higher Education Institution (HEI) or Research Council Institute, usually by authorship. In IRs, institutions may or may not mandate deposit (Darby *et al*. 2009, p.121). The notion of OA mandates is discussed in depth in sections 4.1.6.8 and 4.3.4. The *subject repository* - or subject-based repository as termed by others such as Ware (2004); Armbruster & Romary (2010), is a collection of full-text research outputs with a common link to a particular subject discipline, and deposit of content is usually voluntary (Darby *et al*. 2009, p.121). Common examples are arXiv for physics, astronomy, computer science, mathematics papers, and RePeC (Research Papers in Economics) for economics papers. The *funder repository* is a collection of research outputs and associated data with a common link to one or more funders, and deposit of content is typically mandated by the funder (Darby et al. 2009, p.122). Examples include PubMed Central (PMC) in the US, Canada PMC and Europe PMC (formerly UK PMC).

It is important to note however, that the distinctions between the three types of repositories identified above are at times not clear cut. For example, PMC which can be identified in three different categories as argued by Armbruster & Romary (2010). They argued that PMC is primarily a *subject repository* (i.e. archiving of biomedical and life-sciences literature), but acquisition of content, however, only took off once it was declared a *research repository* capturing the output of publicly funded research by the US National Institutes of Health. In addition, the passing of a deposit mandate by the US Congress transformed PMC into a *national repository*. The latter two repository types are defined by Armbruster & Romary (2010) as follows; *national repositories* systems are ones that require coordination and are designed to capture scholarly output with a view to preserving scholarship, and *research repositories* are usually sponsored by research funding, typically requiring a deposit mandate. Looking at both definitions, there are elements of preserving scholarship, sponsorship from research funders and the typical requirement of a mandate; all of which are synonymous with funder repositories, therefore PMC will be treated as such in this literature review.

2.1.5.3. Subject repositories

Cogprints for cognitive sciences, RePeC for economics, and arXiv for physics, mathematics, astronomy, and computer science, are some of the more widely recognised subject repositories. Other subject repositories have been launched, but with varying levels of success. One of them, specialising in the mathematics discipline, was the Hopf Topology Archive, which was founded in 1992 by Clarence Wilkerson as a way publicising his colleagues' work, and of avoiding the expense and delays of sending paper pre-prints through the mail, especially overseas (Jackson, 2002, p.23).

Subject repositories emerged due to the uptake of the internet, but primarily as a result of the 'pre-print culture' that had become embedded in particular disciplines. This pre-print culture refers to;

"the practice of distributing research articles before they have been peer reviewed to colleagues around the world; to establish ownership of the piece of research, to move the subject along, and to invite critical commentary." (Swan & Brown, 2005, p.2).

Use of subject repositories evolved from e-mail which was the first formal method by which pre-prints were distributed electronically in the mid-1980s (Taubes, 1993, p.1246). However, the limitations of the e-mail method of distribution led Paul Ginsparg, a particle physicist at the Los Alamos National Laboratory, New Mexico, in 1991, to conceive of a more efficient system (arXiv) in which physics (and later, computer science and mathematics) pre-prints could be stored and be accessible from a central location (Taube, 1993, p.1247). arXiv was a success in the physics discipline, because theoretical physicists depend on the work of their predecessors, hence the information most important to them is often too recent to have been published; and for experimental physicists, experiments in high-energy physics are very expensive, often physicists cannot wait for formal publications (Lawal, 2002b). arXiv's inclusion of a facility for post-publication criticism, along with the importance of maintaining a reputation among peers, ensures that it sustains a remarkably high quality of research material (Ball, 2004). An analogy can be drawn between the beginnings of arXiv and that of the journal. In the 17^{th} century, scientists' communications evolved from correspondence through letters to the creation of a more efficient publishing programme in the form of a journal; likewise, physics scholars' communications evolved from email to a more efficient system for communicating their research, in the form of arXiv.

The pre-print culture inherent in disciplines such as physics, computer science and mathematics is however, not so much apparent in others such as chemistry.

This is partly because; patent literature is vital to research in chemistry and the potential to patent a specific research finding may be hampered if the information is made available online before the patent has been applied for and awarded (Lawal, 2002b; Jackson, 2002, p.27). This partly accounts for the demise of the Preprint Archive, which stopped accepting new submissions of chemistry papers in 2004 owing to a total of only about 300 pre-prints that had been submitted since its conception four years earlier (Jackson, 2002, p.27).

Another reason for this lack of pre-print culture in certain disciplines is not so much the nature of information and the information-seeking behaviour of scholars; but rather, the policies of some biomedical sciences publishers. Franz Ingelfinger, the editor of the New England Journal of Medicine in the 1970s adopted a policy of declining to referee or publish research that had been previously published or publicised elsewhere (Harnad, 2000). The main tenets of this "Ingelfinger rule" were the arguments that publishers' revenue streams had to be protected from material that had already been freely available online; and also, that the refereeing system had to be protected from allowing referees to squander their time on a paper that had already been published elsewhere (Harnad, 2000). Hence the limited success of other biomedical sciences subject repositories such as Netprints.org, which had been initiated by the British Medical Journal in 1999 is attributed to many of the top biomedical journals—including the Journal of the American Medical Association, the New England Journal of Medicine, and Science adopting the "Ingelfinger rule" (Harnad, 2000; Jackson, 2002, p.27).

2.1.5.4. Funder repositories

Funder repositories such as PMC, the now defunct ERSC (Economic and Social Research Council) Society Today, Europe PMC and PMC Canada have provided a central locus in which publicly funded research can be made freely available. The PMC model was launched in the US in 2000 by the National Library of Medicine (NLM) to digitize biomedical and life sciences journal literature (PMC … [n.d.]). Since its launch, PMC has grown and includes content from 1149 participating journals, of which 237 are under the National Institutes of Health portfolio, whereby the journal commits to depositing all NIH-funded articles

(Nariani, 2013, p.77). As of February 2013, 2.6 million articles are archived in PMC (PMC … [n.d]). PMC's "mirror" sites, Europe PMC and PMC Canada, hosting almost the same content and search and browse features were launched by the PubMed Central International (PMCI) consortium in 2007 and 2009 respectively (Nariani, 2013, p.76).

Deposit of journal literature in PMC is available through a number of ways. These include self-archiving by the author through the Manuscript Submission System (*only* post-prints can be made available this way) or by the publisher, who can deposit the final published PDF on behalf of an author funded by particular funding agencies (McEntyre *et al*. 2011, p.D60).

2.1.5.5. Institutional Repositories

The first IR to emerge was DSpace at Massachusetts Institute of Technology, in 2002 (Ware, 2004, p.115). IRs were created to serve the purpose of hosting and preserving mainly journal articles and pre-prints, but they also provided an opportunity to include other content as well; such as theses and dissertations, datasets, courseware, and digitised copies of works from the special collections of the hosting institution's library (Suber, 2012, p.52).

IRs have been categorised by Smith, Chudasama & Yates (2010) into three forms, based on the way they secure content; passive, incentivised, and mandated. *Passive IRs* essentially rely on content drifting in as and when staff become aware of the repository for themselves. *Incentivised IRs* on the other hand, typically have one or more dedicated staff involved in managing, advocating and developing the repository. *Mandated IRs* encompass all the elements of incentivised IRs, but are also underpinned by an institutional mandate, requiring staff to deposit their research.

In general, IRs have been developed through free sharing of open source software (OSS) by computer programmers. OSS is;

> *"software that is equipped with licences providing current and future users with the right to use, inspect, modify, and distribute modified or unmodified versions of the software to others."* (Raza, Capretz & Ahmed, 2012, p.1109).

OSS was a phenomenon that originated in the 1950s and gained considerable ground in the 1970s. Decades later, as the US economy emerged from the 1991-1992 recession, computing and internet communications came to the forefront of fuelling economic growth (Weber, 2004). In this ‘new economy’ that was information driven, OSS was gradually beginning to lay its foundation as an important tool that would be used for managing and indexing IRs. The indexing of IRs was made possible by the Open Archives Initiative. Paul Ginsparg and other OSS experts convened in New Mexico in 1999 to find ways of enhancing interoperability standards for improved access to repositories through the Protocol for Metadata Harvesting (PMH). At this convention, called the Open Archives Initiative (OAI), delegates acknowledged that the highly distributed nature of scholarly literature in various repositories on the World Wide Web made it difficult to locate the required literature through searching. Therefore, OAI-PMH provided an opportunity to avert this problem by allowing tagging of critical information (such as author, date, title etc.) of scholarly literature, and making the many distributed repositories "interoperable". In this way, the repositories could all be harvested by cross-archive harvesters such as OAIster or BASE into a single, global seamlessly-searchable OA archive (Harnad *et al*. 2004).

IRs were conceived out of competition for who was going to be responsible for dissemination of an institution’s intellectual content via the internet. Individual institutions viewed themselves as having that responsibility, and they viewed subject repositories to be competitors (Basefsky, 2009). Before IRs, an aggregated system for scholarly publishing in which the journal fulfilled four different and specific functions existed. These functions of registration, certification (peer review), awareness (communications) and archiving – all bundled in the journal, left academics not having much control of how they communicated their work (Prosser, 2003, p.167). IRs provided a new disaggregated system of scholarly communications in which they performed all but one of the journal’s functions above – peer review. Though not possessing an infrastructure for peer review themselves, IRs allowed for inclusion of post-prints, thereby providing institutions with a cost-effective way of both archiving and showcasing their research output.

2.1.6. Social and policy drivers of OA

In addition to the technological developments and cultural practices in particular disciplines discussed above, advocacy by OA scholars and the formulation of policies by funding agencies and governments also played a crucial role in driving OA to the forefront of scholarly communications.

2.1.6.1. The 'Subversive Proposal'

Harnad's (1990) notion of 'Scholarly skywriting' was an initial step of how scholarly activism could act as a social driver for revolutionising scholarly communications. However, it is Harnad's (1994) 'Subversive Proposal' that made the greatest impact in introducing the idea of OA. The 'Subversive Proposal' made recommendations for the revolution of scholarly communications by encouraging scholars to deposit their work in an "anonymous File Transfer Protocol" (sites where users do not need to identify themselves, thereby, typing "anonymous" when prompted for a username) archive or website so as to make it as openly accessible as possible. Harnad (1994) however acknowledged that there was an issue of quality control due to lack of peer review which was done almost exclusively by paper publishers.

Expectedly, such a new paradigm in scholarly communications provoked debate among scholars and publishers. Apart from the issue of lack of quality control stated by Harnad (1994), the debate centred on the scalability of the internet and the cost of what Harnad (1994) described as 'esoteric publishing'. Harnad (1994) defined esoteric publishing as 'work done by the few for the few' i.e. the exchange of information among researchers working at a high level is different from that of mass market publishing such as novels. Okerson & O'Donnell (1995) stated their uncertainty in this as shown in their question below:

"If a large and diverse body of authors produce material and a large and diverse body of readers come looking for it, it is far from obvious that the match of author to reader will be easy and transparent. The nagging question for many Internet services today is, does

it scale up? If the whole world does this, can we still afford to do it so cheaply?" (Okerson & O' Donnell, 1995, p.4).

Okerson & O'Donnell (1995, p.4) added, in relation to the uncertainty of both cost and quality control issues, whether in future there would be a requirement to organise, control and referee the archived material.

Although there was growing awareness and debate of OA to varying degrees across all stakeholders, it lacked a widely recognised definition. Therefore, in 2002 the BOAI definition of OA detailed in section 4.1.4 was adopted.

2.1.6.2. Budapest, Bethesda, and Berlin conventions

Two years after the OAI, in December 2001, some OSS experts, together with librarians, publishers, policy makers and scholars convened in Hungary to formally address the issue of OA and formulate the definition of OA highlighted in section 4.1.4. The BOAI (2002) emphasised that, although OA access to peer-reviewed journal articles is the goal, the definition also encompasses any pre-prints that authors might wish to put online for comment or to alert colleagues to important research findings.

Further developments and declarations followed soon after the BOAI; of note were the Bethesda Statement (April 2003) and the Berlin Declaration (October 2003). These two attempted to build on BOAI's principle of OA; the major tenet of the Bethesda Statement was immediate deposit (self-archiving) of articles in a repository;

> *"A complete version of the work and all supplemental materials, including a copy of the permission as stated above, in a suitable standard electronic format is deposited immediately upon initial publication in at least one online repository that is supported by an academic institution, scholarly society, government agency, or other well-established organization that seeks to enable open access, unrestricted distribution, interoperability, and long-term archiving."* (Bethesda Statement, 2003, n.p.).

The Berlin Declaration, on the other hand, sought to promote the internet as an "emerging functional medium for distributing knowledge". Moreover it placed emphasis on all 'open access contributions'; these include original scientific research results, raw data and metadata, source materials, digital representations of pictorial and graphical materials and scholarly multimedia material (Berlin Declaration, 2003). Another difference between the Berlin and Bethesda statements was that the Berlin Declaration (2003) seemed to emphasise that the self-archiving of articles in a repository, as promoted by the Bethesda Statement (2003) was faced with 'legal and financial aspects'. Therefore, the Berlin Declaration encouraged its signatories to aim to find solutions that support further development of the existing legal and financial frameworks in order to facilitate optimal use and access to scholarly literature.
Both the Bethesda Statement (2003) and Berlin Declaration (2003), however, share the common principle that:

> *"for work to be OA, the copyright holder must consent in advance to let users copy, use, distribute, transmit and display the work publicly and to make and distribute derivative works, in any digital medium for any responsible purpose, subject to proper attribution of authorship."* (Suber, 2003, n.p.).

The Berlin Declaration's focus on 'OA contributions', led to an important question; what research outputs should be made OA?

2.1.6.3. OA and research outputs

Harnad (2005) suggested that institutions could 'require' authors to self-archive journal articles in their institutional repositories, but also 'encourage' the self-archiving of other research outputs such as peer-reviewed conference proceedings and books, which happen to be important outputs in some disciplines. Scholarly books are central in humanities disciplines such as history for example, where writing at least one scholarly book is a general requirement for the tenure of history academics (Dalton, 2009, p.110). Technical reports and conference proceedings are particularly important in the engineering field. This is because conference proceedings are more current sources of information on the progress or results of research and development, and technical reports are important because they contain substantially more data than journal articles (Gould & Pearce, 1991).

The Berlin Statement (2003) as indicated above emphasised the need to not only make peer-reviewed literature openly available, but also to make "open access contributions" such as data openly available. The importance of making research data openly available is captured in Molloy's (2011) assertion:

> *"The more data is made openly available in a useful manner, the greater the level of transparency and reproducibility and hence the more efficient the scientific process becomes, to the benefit of society." (p.1).*

This quote alludes to two of the several arguments for making research data openly available; 'reproducibility' and 'transparency'. Provision of supporting experimental and observational data allows others to identify errors, to reject or refine theories and to reuse data (Boulton, 2012, p.441). With regards to the issue of transparency, an example is the Climatic Research Unit email controversy in 2009, also known as 'Climategate' (Dellingpole, 2009), where it was alleged that climate change data was manipulated in order to suppress criticism from climate change critics. The significance of open sharing of research data will be discussed further in section 2.2.3.

2.1.6.4. Routes to OA

Following the Budapest (2002), Berlin (2003) and Bethesda (2003) declarations, Harnad *et al*. (2004) coined two terms to describe the two routes for making scholarly literature openly available; gold OA and green OA. *Gold OA* refers to publishing an article in an OA journal, and G*reen OA* refers to "publishing an article in a non-OA journal, but also self-archiving it an OA repository" (Harnad *et al*. 2004). OA journals perform their own peer review, just like conventional journals; whereas through the green route, repositories do not perform peer review, but host content that has been peer-reviewed elsewhere Suber (2012, p.52). The Directory of Open Access Journals (DOAJ) a portal created in 2003 on a project supported by the Open Society Institute; define OA journals as "journals that use a funding model that does not charge readers or their institutions for access." (DOAJ ... [n.d.]). There are two types of OA journals, full and hybrid; with full OA journals providing OA to all their research articles, hybrid OA journals provide OA to some articles and toll access to others (Suber, 2012, p.140). Most hybrid OA journals charge a publication fee for the OA option, hence authors who can cover the publication fee get immediate OA for their articles, and those who cannot or prefer not to, get toll access.

In the gold OA business model, cost recovery by the publisher is switched from reader to author (through author-payment or payment by funder), thereby making it possible for the author to have their paper appear in an OA journal immediately after publication. Through the green route, the pre-print or post-print (and in some cases the final article) is made openly available in a repository usually under an embargo period which varies from a few to several months depending on the discipline – the latest guidelines from Research Councils UK (RCUK) stipulate a 6 month embargo for STM disciplines and 12 months for arts, social sciences and humanities disciplines (RCUK, 2012).

2.1.6.5. Is 'open access' the same as 'free access'?

In a bid to promote further understanding of OA, some scholars attempted to address the question of whether 'open access' is 'free access'. Suber (2002) used what he called the 'double payment problem' in scholarly publishing to explain. The double payment problem is when institutions pay subscriptions to access articles written by authors whose research they (or the taxpayer) have funded. He distinguished two types of fees; 'access fees' which pay for access and come in the form of subscriptions and licences etc. and 'dissemination fees' (which are now commonly referred to as article processing charges (APCs)) which pay for publication and distribution rather than access. Suber (2002) argued that, if the full cost of dissemination is paid by the author (or by the author's funder), then they have completely covered its costs and can offer access free of charge; in other words, dissemination fees solve the problem of free online access.

Willinsky (2006) however argued that 'open access' is not 'free access' in that a substantial amount of investment is made in terms of creating and distributing scholarly work; he acknowledges though that, that investment may have been paid for by the public. Anderson (2004, p.206) attempted to address the question using what he called the two myths of OA; the myth of free information and the myth of information as a public good. On the first myth Anderson (2004, p.206) argued that distributing information to others at no charge does not imply that the information is free, but means that its creator has chosen to absorb the costs of creation and distribution rather than try to recover them. On the second myth Anderson (2004) asserted that;

"The fact that something is good for people, or the fact that its broad distribution would be beneficial to the general public, does not make it a public good. What makes something a public good is legal public ownership." (p. 207).

Another issue that required clarification was what sort of 'access' is truly 'open'? Suber (2003) used 'price barriers' and 'permission barriers' to explain this. He mentioned that price barriers such as subscription rates are a limiting factor of accessing information; however, it is the permission barriers arising from statutory tools such as copyright and licenses that can determine whether an article is openly accessible to read, download, copy, share, store, print etc. Suber's (2003) argument of permission barriers being essential in determining the 'openness' of scholarly literature, draws out an important point about of the necessity of a legal infrastructure in a digital environment.

2.1.6.6. Creative Commons Licences

In 2002, The Creative Commons (CC) organisation introduced licences with conditions including: Attribution (BY), Share Alike (SA), Non-commercial (NC), No derived works (ND). These licence conditions effectively allowed content creators to address which rights they reserved, and which rights they waived for the benefit of recipients or other creators (Chen & Tsai, 2009). CC licensing was created upon realisation that immediate and unrestricted access to scientific ideas, methods and results was not immediately compatible with the stringent rules of copyright; which apply fully, automatically and by default, to all published works (Brown, 2003). But by 2011, only 24 per cent of all the OA journals listed in the Directory of Open Access Journals (DOAJ) had adopted CC licences

(Suber, 2011). This was possibly due to the lack of clarity of some of the licences; for example, for the licence NC there was no standard way of defining what constitutes ‘commercial use’ as this differs across the legal structures of countries.

To mark the 10th Anniversary since of Budapest Open Access Initiative (2002), BOAI signatories reconvened in 2012 in an initiative called BOAI-10 in which they reaffirmed the original OA definition and endorsed CC-BY as the optimal licence for the publication, distribution, use and re-use of scholarly work (BOAI-10, 2012) as it allows data-mining. Furthermore, research funders such as the Wellcome Trust have also endorsed the CC-BY licence through a press release in October 2012. Wellcome Trust announced that the rationale behind their support of CC-BY was that full research and economic benefit of published content could only be realised when there were no restrictions on access to, and reuse of the content, and this could be done whilst still allowing publishers to recoup costs (Wellcome Trust, 2012). Moreover, the Trust asserted that the CC-BY licence helps to mitigate the “competing interest problem” of publishing pharmaceutical-sponsored research. In other words, under the CC-BY licence anyone can sell reprints of an article to a pharmaceutical company, whereas under a non-commercial licence only the publisher would retain these rights.

Some OA advocates however strongly disagree with this endorsement. For example, Thatcher (2012, p.2) asserts that for authors of articles and books in the humanities and social sciences, using a CC-BY license makes it impossible for an author or publisher to exert any control over how translations are prepared and published abroad. Moreover, others such as Morrison (2011) believe that CC-BY is not sufficient for data and text-mining;

> *“The Creative Commons licenses are designed as a means for creators to waive rights that they would otherwise have under copyright; they do not place any obligations on the Licensor. There is nothing to stop a creator from using a CC-BY licence with a locked-down PDF with extra Digital Rights Management designed to prevent data and text-mining.”* (Morrison, 2011, n.p.).

In contrast with this view is the Wellcome Trust (2012) who argue that CC-BY licences are compatible with data and text mining in that they provide that attribution must be done in a way that is appropriate to the media used, “so as to avoid rigid rules that block uses of licensed materials”. Therefore, “as a matter of good practice”, Wellcome Trust encourage text-miners to cite the dataset (including the query they used) in all publications which make use of text-mined facts.

Other scholars such as Graf (2012) support CC-BY licences for their ability to deal with contentious issues such as orphan (or semi-orphan) works, especially in some countries like Germany which do not have full copyright transfer to publishers. Without CC-BY in such countries, there would be a requirement to contact authors in order to obtain reuse rights, in which case tracing and contacting the author after for example, ten or more years since an article was published could prove to be difficult (Graf, 2012, p.2). Graf (2012) however, agrees with Thatcher (2012) on the notion of CC-BY presenting loss of control of translated scholarly literature, nevertheless Graph (2012, p.2) states this as a ‘minor disadvantage’ compared to other benefits CC-BY licences possess.

With CC licences seen as not intended, or appropriate for research data, a group of individuals from both the UK and US, representing academia, funding agencies and the not-for-profit sector drafted the Panton Principles in 2010 to address this issue (Murray-Rust *et al.* 2010). The Panton Principles recommend use of alternative licences such as the Public Domain Dedication & Licence (PDDL) and CCZero to allow researchers to freely share, modify, and use databases or their contents (data), either together or individually (Murray-Rust *et al*. 2010). Use of CC-BY together with PDDL and CCZero licences should therefore provide enough infrastructure for both journal articles and the datasets on which they are based to be made openly accessible.

The Budapest (2002), Bethesda (2003), and Berlin (2003) conventions, combined with the emergence of Creative Commons licensing and the activism of OA advocates such as Steven Harnad (1990; 1994; 2004) and Peter Suber (2002; 2003; 2004), brought OA to the forefront of discussions in scholarly communications in the UK. These discussions took the form of a parliamentary enquiry by the House of Commons Science and Technology Parliamentary Committee in 2004.

2.1.6.7. UK House of Commons (2004) enquiry and subsequent events

The aim of this enquiry was to investigate ways of addressing the serials crisis which had seen subscription charges by some publishers, Blackwell Publishing for example, rising by as much as 200 per cent in ten years, and HEI libraries paying £76 million each year to access publicly funded research (Wellcome Trust, 2004, pp.3-4). From the various recommendations made, of note was one that called for RCUK to mandate grantees to archive peer reviewed journal articles in IRs within one month of publication or within “a reasonable period to be agreed following publication”. Another recommendation was for the government to ‘consider’ providing funds for authors to publish their primary research data (House of Commons, 2004a, p.102).

Although the report acknowledged that IRs improved access to journal articles, it however recommended that a more “viable” solution such as the “author pays” (gold route) model would be required in the long term. The Government responded to this recommendation by stating that it was not convinced that the gold route was more sustainable than the green route (House of Commons, 2004b). Also, although the Government accepted the principle of primary research data being made openly available, it rejected the recommendation of providing additional funding to researchers. Rather, it suggested additional investment be made available by research councils to fund data facilities such as the Arts and Humanities Data Service (AHDS) and the Economic and Social Data Service (ESDS) (House of Commons, 2004).

2.1.6.8. The emergence of funder mandates

Following the recommendations of the House of Commons (2004) enquiry, funding agencies began to endorse OA in their research funding policies. The first was the Wellcome Trust, the UK’s largest biomedical research charity which announced the world’s first funder mandate in 2004. This mandate required its grantees to deposit peer-reviewed journal articles in PMC, within six months of publication. Formulation of this policy had been directly influenced by Wellcome

Trust's "Economic analysis of scientific research publishing" report published in 2003 (Wellcome Trust, 2004). This report sought to investigate how the economics of the publishing sector affected the way in which scientific research was disseminated. The findings were that the dominance of large publishers such as Elsevier, which then had a global market share of 25 per cent in the UK, and 30 per cent in the US, had led to 'market imperfections' whereby such publishers were able to maintain high journal prices at the expense of scholars. It recommended research funders (including Wellcome Trust) to introduce other ways of 'opening up the market' such as setting up a central repository based on the PMC model. The result of this was UKPMC, which was launched in 2007 and funded by nine UK research funders, including the Wellcome Trust, and the Joint Information Services Committee (JISC) to provide free access to a permanent online archive of peer-reviewed research papers in the medical and life sciences.

Following Wellcome's Trust mandate, in June 2005, RCUK adopted the following stance:

> "*Ideas and knowledge derived from publicly-funded research are made available and accessible for public use, interrogation, and scrutiny, as widely, rapidly and effectively as practicable."* (RCUK, 2005, p.1).

After this announcement, RCUK immediately announced a policy mandating the deposit of journal articles or conference proceedings in institutional repositories "at the earliest opportunity". The policy stipulated that the mandate did not include deposit of research data. This was due to the need for further work on policies and procedures to determine where the research data would be deposited i.e. in an author's institutional repository or in a research council's repository, and also the terms on which the data would be made accessible (RCUK, 2005).

In other European countries such as France, Netherlands and Germany, discussions on OA were beginning to take shape on a political level. But it was in the US where the most significant changes took place. In 2004, the House Appropriations Committee adopted a set of recommendations for the federal budget, one of them focused on improvement of access to publicly funded research (Suber, 2006). In 2005, the resultant bill culminated in the NIH adopting a policy "requesting" all NIH research grantees to submit an electronic version of their final peer-reviewed manuscripts, no later than twelve months after the official date of publication into PMC (NIH, 2005). However, owing to the very low compliance rates of 4 per cent, in 2008, a new policy under the NIH Public Access Act was announced (Suber, 2006). Rather, than "requesting" as in the former policy, it "required" NIH grantees to submit to PMC an electronic version of their final, peer-reviewed manuscripts upon acceptance for publication, to be made publicly available no later than 12 months after the official date of publication (NIH, 2008). Various measures to enforce compliance were introduced; for example, the compulsory inclusion of a PMC ID on each paper authored or co-authored by an NIH grantee.

After the release of the NIH mandatory policy many publishers began announcing their willingness to co-operate with it (Suber, 2009c), however, some expressed that the NIH Public Access Act violated copyright (Suber, 2008a). Suber (2008a) noted that in the policy, NIH grantees publishing an article in a journal would retain the right to comply with the NIH policy - even if they transferred all of their other rights to the publisher. In other words, the policy "did not depend on publisher consent or co-operation, it simply required grantee compliance"; authors were obliged to look for another publisher if a publisher refused to accommodate the NIH policy.

2.1.6.9. What is "open" and what is "access"?

Suber (2008b) asserted that despite the progress that had taken place with regards to increased awareness of OA among academics and the policy response by governments and funding agencies, the was need to specify the degree to which articles were openly accessible. In other words, there was need to find an answer to the question what is "open" and what is "access"? Therefore, in April 2008, Suber (2008b) along with Harnad jointly coined the terms 'weak OA' (meaning restricted access to the full text of an article) and 'strong OA' (free availability of full text immediately upon publication) as a way of addressing this.

Suber (2008b), however conceded that these terms added to more confusion in terms of the specific rights retained by readers of scholarly work. Hence in August 2008, Suber (2008b) proposed new terms; 'gratis OA' (meaning free, online access) and 'libre OA' (meaning free online access, plus various re-use rights (such as data-mining, remix and republication rights)). Suber (2008) asserted that, in other words, 'gratis OA' explains the removal of price barriers alone and 'libre OA', the removal of price and at least some permission barriers. BOAI-10 has since adopted the libre-gratis terminology:

"When possible, funder policies should require libre OA, preferably under a CC-BY license or equivalent."(BOAI-10, 2012, n.p.).

To further build on Suber's (2008) libre-gratis terminology, in 2012 the Scholarly Publishing and Academic Resources Coalition (SPARC), Public Library of Science (PLoS), and Scholarly Publishing and Academic Resources Coalition (OASPA) collaborated to produce a resource named the 'OA Spectrum'. The OA Spectrum looked at the following factors; reader rights, reuse rights, copyright, author posting rights, automatic posting, and machine readability, to determine whether an item is either closed access (CA) or OA, a summarised illustration is shown in Table 2-1 below:

Table 2-1: A summarised table showing opposite ends of the OA Spectrum (adapted from SPARC, PLoS, OASPA, 2012)

	Closed access	Open access
Reader rights	subscription, membership, pay-per-view, or other fees required to read	free readership rights immediately upon publication
Reuse rights	no reuse rights beyond fair use	generous reuse & remixing rights (CC-BY license)
Copyrights	publisher owns copyright	author holds copyright with no restrictions
Author posting rights	author may not deposit any versions to third-party repositories or websites	author may post any version to any third-party repository or website

Automatic posting	no automatic posting in third party repositories	journals make copies of articles automatically available in trusted third-party repositories (e.g., PubMed Central) immediately upon publication
Machine readability	article full text & metadata not available in machine-readable format	article full text, metadata, citations & data, including supplementary data, provided in community machine readable standard formats through a community standard API or protocol

The BOAI (2002) definition of OA access focused on mainly *peer-reviewed* versions of journal articles. Whereas from Table 2-1 it can be seen that in terms of author posting rights, authors can post *any* version of their works i.e. including pre-prints. In other words, according to the OA spectrum, the BOAI (2002) definition of OA does not fully meet the most open of OA. It can also be concluded that the OA Spectrum is in effect an extension of Suber's (2008b) libre-gratis concept that is detailed on a spectrum.

2.1.6.10. The Finch Report

The most significant indication that OA has been endorsed in the UK as a legitimate channel for communicating scholarly research is the Finch Report of 2012. The UK government commissioned the Finch Committee, (a working group composed of policy makers, librarians, scholars and publishers) to produce a report that addressed accessibility to publicly-funded research and also investigated long-term sustainability of the green and gold routes of OA.

A key conclusion of the Finch Report states:

> *"…repositories on their own do not provide a sustainable basis for a research communications system that seeks to provide access to quality-assured content; for they do not themselves provide any arrangements for pre-publication peer review. Rather, they rely on a supply of published material that has been subject to peer review by others…Our key conclusion, therefore, is that a clear policy direction should be set to support the publication of research results in open access or hybrid journals funded by APCs*" (Finch Committee, 2012, p.55; pp.91-92).

The Finch Report acknowledged the importance of the green route as complementary to the more sustainable gold route which would require a budget of approximately £60m/year from research funders. It recommended immediate and unrestricted access of the published version of all RCUK-funded articles on publisher's open access journals. *Where a publisher does not offer a gold OA option*, it recommended that the green route would be suitable, subject to an embargo period no less than 12 months. The government accepted all recommendations, except one that had called for the reduction or removal of VAT levied on electronic journals to ease the pressure on library budgets. The government stated that it was unable to act on this as VAT rules were agreed at an EU level (Department for Business Innovation & Skills, 2012).

2.1.6.11. Responses to the Finch Report

The RCUK accepted most of the Finch Report recommendations apart from the 12 month embargo recommended on scholarly literature from all disciplines through the green route. Instead, RCUK's 'Policy on Access to Research Outputs' released in July 2012 stated that while a 12 month embargo would suffice for arts, social sciences and humanities disciplines, a 6 month embargo for STM disciplines would be suitable (RCUK, 2012a).

Another important note in the policy was a change in the way article processing charges (APCs) are supported. The policy stated a shift from supporting APCs through both direct and indirect costs as part of grant funding, to that of allocating block grants to HEIs. Each HEI, upon receipt of funding would transfer these charges to their institutional publication fund (RCUK, 2012). The challenges faced by individual HEIs in administering this method of funding have been identified by some scholars. Pinfield & Middleton (2012, p.116) for example, argue that for individual institutions budgeting is difficult when APCs are averaging around £1,200, and a small increase in uptake would have a relatively large impact on spending. Moreover, they state the difficulty of associating publishing costs with a related grant. Particularly in relation to checking compliance with mandates and also confirming whether expenditure can be covered by the originating grant.

The Publishers Association, representing most of UK's commercial publishers endorsed the Report and acknowledged that the Report presented a 'balanced package' of disseminating scholarly literature (Publishers Association, 2012). The Publishers Association's response also called for research funders not to commit to green OA embargo periods of less than 12 months for STM disciplines in cases where publishers do not offer gold OA (Publishers Association, 2012). This is in contrast to the policy set by RCUK (2012a) which imposed 6 month embargoes on all STM research and 12 month embargoes for all arts, social sciences, and humanities scholarly literature.

The Royal Historical Society - a learned society publisher - responded by stating that, although the Finch Report was mainly focused on access and sustainability of STM scholarly literature, there was a risk that the interests of the humanities and social sciences will be made to fit an approach not suitable for their research culture (Royal Historical Society, 2012). Royal Historical Society (2012) stated that this was due to a large part of humanities publications disseminated in the form of monographs and edited collections for which no OA business model has yet been devised. Another reason the Royal Historical Society pointed out was the very large proportion of articles in history journals that were not written by scholars who had received RCUK grants or even located in British HEIs (Royal Historical Society, 2012).

Unlike the Royal Historical Society, whose concerns were mainly based on the cultural difficulties of adopting gold OA in humanities disciplines, the response from another leaned society publisher, the Institute of Physics' (IOP), focused on the economic implications of this 'new publishing model'. IOP stated that the transition period to gold OA required careful managing in order to protect the largely non-profit revenue streams of learned societies (IOP, 2012).

The recommendations of the Report were not welcomed by many HEIs. The Russell Group (representing twenty-four leading research-intensive universities in the UK) for example, stated their concern that scholars from other countries would have free access to research done by UK scholars, while they (UK scholars) had to pay through journal subscriptions to access research material of scholars from abroad (Russell Group, 2012).

2.1.6.12. The Royal Society Report (2012)

Concurrent with the Finch Report was an initiative by the Royal Society to identify the principles, opportunities and problems of sharing and disclosing scientific information (Royal Society, 2012). This initiative was partly motivated by the "Climategate" scandal, which brought the lack of access to research data into prominence (Boulton, 2012, p.441), and also by a prior initiative by RCUK in 2011, titled "Common Principles on Research Data Policy" (Royal Society, 2012). The aim of the Common Principles on Research Data Policy initiative was to provide an overarching framework for Research Councils policies on data policy (RCUK, 2011). The framework was based on the premise that publicly funded research data as a public good, should be made openly available "with as few restrictions as possible, in a timely and responsible manner that does not harm intellectual property". (RCUK, 2011).

In 2012, The Royal Society commissioned a working group composed of journal editors, and senior figures from academia, and research and development organisations, who produced the "Science as an Enterprise" report, in which one of the recommendations stated;

"Scientists should communicate the data they collect and the models they create, to allow free and open access, and in ways that are intelligible, assessable and usable for other specialists in the same or linked fields wherever they are in the world. Where data justify it, scientists should make them available in an appropriate data repository" Royal Society (2012, p.10).

The Royal Society Report (2012), managed to draw responses from some stakeholders such as RCUK, for example, which stated that it welcomed the recommendations and would "carefully consider" them when reviewing its policies (RCUK, 2012b). The Royal Society Report is significant in that it initiated discussions on the general importance of research data across all disciplines. Prior initiatives on the importance of research data were focused on particular disciplines. Of note were the Bromley Principles (climate change research data) and the Bermuda Principles (DNA sequence data).

The Bromley Principles were drafted in 1991 by a committee led by the US government science advisor Allan Bromley in a bid to facilitate “full and open access to quality data for global climate change research” (Bromley, 1991). They recommended the need for data to be made available to climate change researchers at the lowest possible cost i.e. the cost should be no more that the marginal cost of filling a specific user request (Bromley, 1991). Moreover, the Bromley Principles recommended that funding agencies should explicitly define any initial period of exclusive data evaluation and validation by principal investigators so as to prevent them retaining the data indefinitely, thereby inhibiting its widespread use (Bromley, 1991).

The Bermuda Principles were drafted to support the Human Genome Project (HGP), a project launched in October 1990 and funded by NIH to identify and map DNA sequences, in other words, determining the precise order of nucleic acids within a DNA molecule (Contreras, 2010). Realising that rapid release of the HGP project’s vast genomic data was desirable for the advancement of scientific discovery and the consequent improvement of human health; leaders from the HGP, Wellcome Trust, UK Medical Research Council (MRC) and other organisations convened at a summit in Bermuda in 1996. In contrast with the Bromley Principles, the Bermuda Principles did not acknowledge the need for any initial period of data evaluation and validation; instead they recommended making DNA sequence data to be released in publicly-accessible databases within twenty-four hours after generation (Contreras, 2010). The Bermuda Principles were a departure from the typical practice in the biomedical sciences of making experimental data available only after publication, and established rapid pre-publication data release as the norm in genomics and other fields (Contreras, 2010).

2.1.7. Summary

It can be concluded that, while technological advances such as the internet and the World Wide Web may have afforded OA, it is people, (through scholarly activism by OA advocates) and policy (by research funders and governments) that brought it to the forefront of discussions in scholarly communications. Moreover, cultural factors have influenced the uptake of OA to be more pronounced in particular disciplines than others. Within the background of OA, it has been briefly discussed how open availability of research data is just as important as the journal article itself. This “Open Science” (Sieber & Trumbo, 1995, p.18) movement will be discussed in the next section.

2.2. THE CASE FOR OPEN SCIENCE

2.2.1. Introduction

Open science (OS) is the idea that the claims made in a peer reviewed paper should not only be accessible to all but that they be fully supported by a publicly accessible record of all the material that contributes to those claims (Neylon & Wu, 2009, p.543). As such, the OS movement advocates for making data, methods and results freely available on the web (Sieber & Trumbo, 1995, p.18; David, 2010, p.14; De Roure *et al.* 2010, p.2338). The OS movement can be traced back to the 1980s, by biomedical scientists taking part in the Human Genome Project, the Berlin Declaration (2003) (though widely synonymous with OA) and most recently, the Royal Society (2012) leading advocacy for OS.

In addition to data, methods and results, OS has also been described as including; source code (Vandevalle, 2012, n.p.), workflows (Nielsen, 2009, p.32), software tools and laboratory notes (RIN, 2010, p.10) and as asserted by National Research Council (2003, p.37) "'anything' that enables the furtherance of science". In defining OS, the word 'data' has been used as a standalone noun or as an umbrella term covering methods, source code, workflows etc. Therefore, this warrants a discussion on what precisely does data encompass, and in what forms does it exist?

2.2.2. Definition of data

Data itself, as the main component of OS as defined by Sieber & Trumbo (1995); David (2010) and De Roure *et al.* (2010), has many meanings and interpretations. The Royal Society (2012) for example, defines data as;

> "*Qualitative or quantitative statements or numbers that are (or assumed to be) factual … They may be raw or derivative data, but are not yet the product of analysis or interpretation other than calculation." (p.12).*

Another definition given by the Organisation of Economic Co-operation and Development (OECD) describes data as factual records such as numerical scores, textual records, images and sounds, used as primary sources for scientific research (OECD, 2007, p.13). The OECD definition which has heavily influenced UK Research Councils' data access policies (Angus & Pryor, 2011, p.200), does not cover grey literature such as lab notebooks and drafts of scientific papers, nor physical objects such as lab samples (OECD, 2007, p.13).

Data can be distinguished by its origins (NSF, 2005), and its stages of development (Lowrance, 2006). The US National Science Foundation (NSF) distinguishes data into three forms, based on its origins - observational data, computational data, and experimental data. *Observational data* include direct observations of for example, ocean temperature on a specific date or the attitude of voters before an election (NSF, 2005, p.19). Since observations in disciplines such as astronomy and seismology for example, are irreplaceable and cannot be repeated, effective metadata descriptors for preserving raw and contextual data are of fundamental importance (Pepe & Borgman, 2007).

Computational data, on the other hand, result from executing a computer model or simulation (NSF, 2005, p.19). An example of a discipline in which computational data is heavily used is ecology (Thessen & Patterson, 2011, p.18). In ecology, productivity of the ecosystem is rarely measured directly, but rather through use of computed data from other sources to generate measurements such as the amount of carbon levels per unit area per unit time (Thessen & Patterson, 2011, p.18). *Experimental data* result from dissecting the elements of a phenomenon by changing conditions to uncover causal relationships, or to identify variant and invariant elements of physiological or biological processes such as gene expression (NSF, 2005, p.19; Thessen & Patterson, 2011, p.18).

Data sets go through several stages of development; raw, cleaned, augmented, and mature, and this has implications with regards to how they are made accessible (Lowrance, 2006, p.11). First they begin as *raw data*, i.e. the data as initially measured and recorded (this could be observational, computational or experimental data). They are then transformed into *cleaned data* by being quality controlled and having redundancies removed. As they are studied they become *augmented data* by incorporating derivative or 'built' data, i.e. inferences drawn from multiple initial data such as the date of onset of illness, established by reviewing clinical measurements along with interview data (Lowrance, 2006, p.11). As *mature data*, they can be held in databases, or stored in repositories from which they can be retrieved for different purposes (Lowrance, 2006, p.11). There are problems in defining the stages of data suggested by Lowrance (2006) however, in that, data that are cleaned or augmented for one purpose may be ‘raw’ for another (Borgman, 2008, p.30). Determining how much cleaning, analysing, and verification of raw data before it becomes cleaned data with any scientific factual value is a matter of judgment (Borgman, 2007, p.183).

2.2.3. The case for OS

Lyon (2009, p.16) proposes that there are wider societal benefits from OS such as *increased return on investment* of public funds allocated to research through making data outputs openly available for re-use. Another societal benefit is in the form of *efficiency gains* that result from reduced unnecessary repetition of research activity and associated wasteful funding allocations Lyon (2009, p.16). More specifically, the rationale for OS is based on, but not limited to, replication of findings, citation impact, and other academic impacts such as increased productivity of researchers.

2.2.3.1. Replication of findings

Replication involves analysing data by following the original researcher's methods, thus checking the accuracy of the reported results. It also involves using competing analytic techniques or sets of assumptions, hence testing the robustness of the original conclusions to alternative approaches (Hedrick, 1985, p.125). Replication is considered the “scientific gold standard” (Jasny *et al*. 2010, p.1225; Peng, 2011, p.1226). The previous section of this literature review mentioned the “Climategate” scandal which arose due to the Climate Change Research Unit failing to make their data openly available for one of their major publications (Boulton, 2012, p.441). Since replication - which is only possible with the availability of data and detailed methods - enhances the credibility of any research (Hedrick, 1985, p.125), controversy arose because other interested researchers were unable to verify and replicate the findings of the Climate Change Research Unit; hence the credibility of the publication was questioned.

2.2.3.2. Citation impact

The notion of OA articles accruing more citations than toll access articles has been extensively covered by many authors: Antelman (2004); Norris, Oppenheim & Rowland (2008), Gargouri *et al*. (2010), to name a few. There is now a growing number of studies, including those of scholars such as Vandewalle (2012) and Piwowar, Day &Fridsma (2007) for example, who have argued that journal articles that are published with data that has been made available online receive more citations than those that did not.

Vandewalle (2012, n.p.) studied image processing journal papers produced by computer science scholars to see if those that had made available computer code online were cited more than those that did not. The median number of citations for the papers without code online was 25, compared to 76 for the papers with code available online, showing an increase with a factor of 3 (Vandewalle, 2012). Vandewalle's (2012) study however does not take into account that for those papers that were counted as not having their code online, there is a possibility that it could have been made available by the creator at a later period, or may have been available but inaccessible due to broken links.

Piwowar, Day & Fridsma (2007) sought to investigate whether clinical trial publications which shared their micro-array data (i.e. cell data obtained from microscope slides) received more citations than those that did not. Piwowar, Day & Fridsma (2007) examined the citations of 85 journal publications of cancer micro-array clinical trials and found that 41 of the 85 clinical trials (48 per cent) made their micro-array data publicly available on the internet – with most data sets being located on lab websites (n=28). Some datasets were located within public databases (n=14) such as Gene Expression Omnibus (GEO), whilst a few were located on publisher websites (n=14). These figures include some datasets that were located in more than one location. Piwowar, Day & Fridsma (2007, p.1) calculated that the 48 per cent of trials with publicly available micro-array data received 85 per cent of the aggregate citations of the entire 85 clinical trials. Piwowar, Day & Fridsma (2007) concluded that there was a 69 per cent increase in citations to articles that the data accompanied. This correlation was independent of journal impact factor, date of publication, and author country of origin. Although, Piwowar, Day & Fridsma (2007) found there to be a correlation between open availability of data and citations, their study did not prove any causation, in other words, proving that the high citation count was particularly *caused* by open availability of data.

Other researchers (RIN, 2008, p.26) have identified some of the potential benefits for data creators arising from sharing their data.
a) Opportunities for co-authorship of papers:
- researchers who publish and share datasets, are often asked to be co-authors of papers for which re-used data is the basis (RIN, 2008, p.26). Data acts as a 'glue' for collaborative research i.e. scholars work together to generate data and those data are an essential product of the collaboration (Borgman, 2007, p.30)
b) Opportunities for collaboration with others in and beyond subject niche:
- relationships formed through the process of publishing and sharing datasets often lead to collaborations that may not otherwise have been conceived –with other researchers either in the same or in different disciplines (RIN, 2008, p.26)
c) Esteem factors and positive feedback to funding body:
- researchers who share their data also tend to receive acknowledgements (or in some cases direct citations to the datasets themselves) (RIN, 2008, p.26). This recognition, while not valued in research performance assessment, may be included in subsequent grant applications, particularly with those funding agencies that encourage data sharing (RIN, 2008, p.26).

In addition to Borgman (2007) and RIN (2008), Youngseek & Stanton (2012, p.52) interviews of STEM researchers revealed that they 'believed' data sharing would improve their research through for example, time saving in collecting the same data, replicating data for another research project, conducting diverse comparison studies etc. These 'potential benefits' required empirical examination to find out whether it was the case that for example, relationships formed as a result of sharing datasets have led to collaborative activities between the data creator and user and whether any disciplinary differences existed.

2.2.4. Problems/challenges with sharing/publishing research data

There are problems that exist in researchers sharing or publishing their data. One of these relates to data publication not being recognised on the same level as journal articles or books. Other reasons act as barriers for data sharing or publishing, these include: fear or results being challenged, career advancement, time constraints, ethical and privacy concerns.

2.2.4.1. Data and the reward system in scholarly communication

A major barrier in the sharing and publication of data is the lack of a system that rewards scholars for doing so (RIN, 2008; RIN, 2010). Scholars are rewarded, (in the form of funding or tenure) by recognition of their contribution to their field of study – this recognition is registered, in part at least, through citations to journal articles and books (Sieber & Trumbo, 1995). The citation of data is crucial in evaluating the contributions of individual scholars, and giving them credit equal to that of the citation of journal articles and books (Sieber & Trumbo, 1995, p.12; Royal Society, 2012, p.66).

Two reports by the Research Information Network (RIN, 2008; RIN, 2010) noted that research evaluation mechanisms such as RAE and REF are perceived to value above all else, the publication of articles in high-impact journals. Research evaluation mechanisms' perceived failure to explicitly recognise and reward data sharing and publishing effectively works against researchers' valuing data publication as importantly as the article itself (RIN, 2008, p.24). Pisani, *et al*. (2010, p.704) equate disseminating data to "giving away job prospects", as long as funding and promotion depend solely on publishing papers in peer-reviewed journals.

It is noteworthy however, to state that since these two reports; RIN (2008; 2010) there has been growing recognition for data publication to be included in research performance evaluation in the UK. A major advocate for this is the Royal Society (2012, p.73) who are of the view that there is a skill and creativity required to successfully create and acquire data, therefore research evaluation mechanisms should reward data on the same scale as journal articles and other publications

2.2.4.2. Fear of results being challenged

Some researchers are reluctant or fearful of releasing their data as there is a possibility that their initial findings may be re-analysed and challenged by other researchers (Piwowar & Chapman, 2008; Wicherts, Bakker & Molenaar, 2011). When results do not confirm the beliefs of researchers, the motivation for data dissemination may weaken (Krumholz, 2012, p.142). However, in cases when the data are disseminated, it is common practice, as argued by Simmons, Nelson & Simohnson, (2011, p.1360), for researchers to explore various analytic alternatives, select a combination that yields "statistical significance," and to then report only what "worked". Wicherts, Bakker & Molenaar (2011, p.1) investigated the relationship between data withholding and reporting errors in 1148 statistically significant results reported in 49 psychology papers. They discovered that reluctance by researchers to share their data was associated with weak evidence in the findings and a high prevalence of apparent errors in the reporting of statistical results. Wicherts, Bakker & Molenaar (2011, p.5) concluded that the reluctance to share data is generated by the authors' fear that re-analysis will expose errors and lead to opposing views on the results. It is important to note however, that although Wicherts, Bakker & Molenaar (2011) found there to be a statistical association between reporting errors and withholding of results, it does not necessarily mean that a causal relationship exists between the two. In other words there other reasons that could account for the psychologists to have withheld their data, one of them being ethical and privacy concerns. As described in 4.2.4.5 below, ethical and privacy concerns are not uncommon as reasons for withholding data especially in social sciences disciplines.

2.2.4.3. Career advancement

In their paper titled '*Private archives, public needs'* Ceci & Walker (1983, p.417) describe the practice of some researchers in sociology and geography who, over time, build their own personal data collections or "private archives" at the expense of public benefit. Such researchers require the use of datasets such as life transitions and socio-economic milestones, collected years ago, and keep the datasets for themselves so as to mine them productively for many additional years. With the data located in these private archives, they are often unavailable to interested social scientists who could also use them productively for the public benefit (Ceci & Walker, 1983, p.417). The same behaviour was documented by Freese (2007, p.162) who noted quantitative sociologists – who may have spent considerable time writing the code on which their analyses are based, may be reluctant to allow others to benefit from their labour, especially if they are planning further projects using the same code. Some of these 'private archivists', however, as argued by Borgman (2012, p.1069) may have their research career tied into a long-term study of a specific species, locale, or set of artefacts, hence their justification for the need to withhold their data. Such withholding of data however, is not unique to the social sciences. Seventy-five per cent of academic geneticists surveyed by Campbell (2002, p.473) stated the main reason for withholding data was fear of losing patent rights or obtaining future grants.

2.2.4.6. Academic entrepreneurship

Fear of losing patent rights as found in Campbell's (2002) study above, points to the notion of "academic entrepreneurship" as one of the barriers of researchers sharing their research data (Abreu & Grinevich, 2013; Walsh & Huang, 2014). Academic entrepreneurship is defined as;

> *"Any activity that occurs beyond the traditional academic roles of teaching and/or research, is innovative, carries an element of risk, and leads to financial rewards for the individual academic or his/her institution"* (Abreu & Grinevich, 2013, p.408).

As the primary objective of academic entrepreneurship is for academics to commercialise innovations resulting from their research (Grimaldi *et al*. 2011, p.1045) the motivation to share data before it has been commercially exploited is low in some disciplines. This is shown in a study carried out by Blumenthal *et al*. (1997, p.1226) on life sciences researchers which found that the two most common reasons why researchers withheld their data was 'to allow time for patent application' (46%) and 'to protect the proprietary or financial value of the results (other than patent application)' (33%).

2.2.4.4. Time constraints

Many researchers, across various disciplines, have stated *time constraints* as the reason why they were unable to disseminate their data (Wicherts *et al*. 2006; Piwowar & Chapman, 2008; Savage& Vickers 2009). In the process of making data openly available, time needs to be devoted to tasks such as formatting, documenting, and uploading the dataset onto a website or a repository (Piwowar & Chapman, 2008, p.12). A study by Savage & Vickers (2009) of ten papers from two Public Library of Science (PLoS) journals; PLoS Medicine (n= 4) and PLoS Clinical Trials (n=6) revealed that, despite both journals having explicit policies requiring authors to publish their data, none of them did, and when requested, only 1 of 10 data requests were honoured. Authors stated not having time to share their data. Nevertheless, these findings are based on a small sample (n=10) of papers, therefore may not be adequate to make a confident conclusion. A larger sample was studied by Wicherts *et al*. (2006) on 141 journal articles appearing in four journals published by the American Psychological Association (APA). Wicherts *et al*. (2006, p.726) found that only 38 authors (27 per cent) agreed to share their data when requested by other researchers. For those who did share, most of them took considerable time to do so. However, the real reason, as Wicherts *et al*. (2006, p.726) suggest may be due to researchers finding little to no benefit in honouring data requests, rather than due to them not having 'enough time'.

2.2.4.5. Ethical and privacy concerns

Ethical and privacy concerns in disseminating and publishing of research data, are common across various disciplines, although more prevalent in some than in others, particularly in social sciences and humanities disciplines (Ceci, 1988; Perry, 2008; Youngseek & Adler, 2015). These concerns are largely based on the fear that secondary users of data might not respect the promises of confidentiality made to participants (Pisani, 2010, *et al*. p.704). Youngseek & Adler's (2015, p.416) study of social scientists' data sharing behaviour revealed some researchers feeling that human subjects confidentiality constraints increased both the "risk and effort" of data sharing data. Moreover, Ceci (1988, p.47) noted in his study that for psychologists, "'divulging' data would not be in keeping with the spirit of their 'subject solicitation agreement'". This view is upheld even when researchers have been mandated by their funders to make their data publicly available. An example is that of a study by Perry (2008) on the data sharing behaviour of scholars funded by the Social Sciences and Humanities Research Council of Canada (SSHRC). Perry (2008, p.145) found that even under the SSHRC mandate requiring grantees to make their research data openly available, many researchers withheld publishing their data, citing ethical and privacy concerns. Many of these researchers felt they had ethical obligations to protect their subjects, moreover, they felt that the mandate requiring them to publish their data was in direct conflict with the criteria imposed by the ethics boards which govern their work (Perry, 2008, p.145).

2.2.5. Summary

OS serves the main function of verification and replication of research findings. A major challenge with OS however, is the lack of a reward system for recognising data sharing and publication. The impact of data reuse presents data creators with potential benefits such as the possibility for increased citations and collaboration, and data users with the potential of increased productivity. Such scholarly behaviour is influenced by various factors, some of which are discussed in the section 2.3 below.

2.3. INFLUENCES ON THE DISSEMINATION & PUBLISHING BEHAVIOUR OF SCHOLARS?

2.3.1. Introduction

The previous two sections have discussed dissemination and publishing of scholarly outputs, but what it is in particular that influences scholarly behaviour? These influencers can be categorised into social/cultural and epistemological factors, and institutional policies.

2.3.2. The influence of social/cultural and epistemological factors on scholarly behaviour

One of the ways of understanding the influence of sociological processes in influencing scholarly behaviour is through the works of Robert Merton (1957). Merton's (1957) work on the sociology of science views science as a "social community" in which scholarly behaviour is built around a social construct of shared meanings and shared artefacts whereby the actions of an individual scholar are influenced by his/her peers. In this social construct, Merton (1957, p.646) asserted the existence of the following norms, commonly referred to by the acronym CUDOS; Communalism, Universalism, Disinterestedness and humility, and Organised Scepticism. *Communism* is based on the premise that substantive findings of science are a product of social collaboration and assigned to the community. *Universalism* relates to physical laws being the same everywhere, regardless of nationality or the social attributes of an individual. *Disinterestedness and humility* relates to the personal attributes of prioritising community interest rather than self-interest, and that a predecessor should be acknowledged for their role in creating new knowledge. Finally, *Organised Scepticism* is whereby scientists are predisposed to actively check claims and challenge falsity where it exists. Scientists are rewarded with recognition for their originality and for living up to the norms above (Merton, 1957, p.297). However, they more than often deviate from such norms, a major source of this deviation being – competition for recognition (Hagstrom, 1965, p.19).

2.3.2.1. Competition for recognition

Within the context of competition for recognition, there is the issue of how the extent or degree of competition influences the way scholars behave in disseminating their research. Hagstrom (1965, p.73) asserts that the relative degree of competition in each discipline can predict the way scholars behave. Hence, in disciplines such as physics, which is based on logically precise theories or "paradigms", as well as highly precise experimental techniques; relatively more recognition can be given to the first results reported, with less being accorded for replication (Hagstrom, 1965, p.73). It has been argued that there is an intensity of competition in physics (Hagstrom, 1965, p.73). Kuhn (1962, p.11) describes the 'paradigm' as a body of theory that is subscribed to by all members within a discipline. In other words, scholars that have their research based on shared "paradigms" are committed to the same rules and standards for scientific practice (Kuhn, 1962, p.11).

"Thus in Kuhnian terms; the more paradigm-bound a field is, the more predictable, visible and replicable are research results and the more limited is permissible novelty …" (Whitley, 1984, p.119).

On the other hand, in disciplines with less well-developed paradigms such as chemistry and molecular biology (compared to physics, mathematics etc.), where interpretation of results must often proceed in a highly cautious manner - an intermediate level of competition can be expected (Hagstrom, 1965, pp.73-74).

The degree of competition can also be understood through the 'urban-rural' ways of life framework proposed by Becher (1989). Becher (1989, p.79) studied twelve academic disciplines and found that they were 'inhabited' by what he termed 'urban' and 'rural' scholarly communities that not only differed in their communication patterns, but also in the nature and scale of the problems their inhabitants are engaged in (Becher, 1989, p.79). Becher (1989, p.79) described 'urban' scholarly communities as inhabiting disciplines such as high-energy physics, as being characterised by a high people-to-problem ratio, whereby there is a high level of collective activity, and an emphasis on rapid publication to ensure priority. As such “competition in urban life can become intense, even cut throat ...” Becher (1989, p.80).

A rural environment such as in academic law on the other hand, has a low people to problem ratio whereby researchers typically cover a broader stretch of intellectual territory in which the problems are not sharply demarcated (Becher, 1989, p.79). Therefore, competition is comparatively lower than in its urban counterpart because there are plenty of topics to explore and no incentive in tackling one on which someone else is already engaged (Becher, 1979, p.79). Becher (1989, p.79) identifies preprint and conference dissemination as channels for establishing credit for first discovery as more typical in urban than in rural communities. Giving modern languages and history as examples of disciplines in which books earn more prestige for their authors than articles, Becher (1989) argues that; generally, books are a predominantly rural output, whereas, journal articles are predominantly urban output (Becher, 1989, p.82).

Whitley (1984) proposed a framework highlighting the relationship of both epistemological and social structures within disciplines, based on two dimensions; ‘mutual dependency’ and ‘task uncertainty’. Whitley (1984, p.87) defined *mutual dependence* as the degree of dependence of scientists upon particular groups of colleagues in order to make competent and significant contributions, and acquire prestigious reputations, which lead to material rewards. Hence, as the degree of mutual dependence increases, competition for reputations and control over the direction of research in that field grows (Whitley, 1984, p.89). *Task uncertainty* refers to the degree of predictability in producing and evaluating knowledge claims; hence, the less clear (or uncertain) it is which problems are most important, the greater the variability of problems dealt with in the field (Whitley, 1984, p.121).

The degree of task uncertainty and mutual dependence has a bearing on the type of research output normally produced within a discipline. Take history for example, a discipline characterised by low mutual dependence and high task uncertainty; although articles are important, they rarely substitute books - articles play a *secondary role* of: (a) discussing a specific/technical question, (b) discussing data not addressed in a book or, increasingly, (c) testing ideas for a future monograph approaching publication (Harley *et al*. 2010, p.398). Books, on the other hand, have the scope to allow for the “exposition and presentation of a solid, sustained, and closely reasoned argument” (Harley et al. 2010, p.396). However, as will be seen in section 2.3.5, scholarly behaviour is open to influence from institutional structures, whereby history scholars for example, are under pressure to publish in high-impact journals rather than books, for submission to research evaluation mechanisms such as the REF.

2.3.3. Scholarly behaviour in disciplinary groups

Discipline taxonomies can be used to group those disciplines in which scholars exhibit more or less similar scholarly behaviour, based on social/cultural and epistemological factors. The seminal work of Kuhn’s (1962) *The Structure of Scientific Revolutions* made a significant contribution to the foundations of discipline taxonomies. Kuhn (1962, p.12) asserted that the paradigm is ‘a cluster of beliefs’ that serves to provide a consistent account of most of the phenomena of interest in the discipline and dictates how research should be interpreted in a discipline. He depicted the natural sciences as going through periods of ‘revolution’ whereby ‘normal science’ i.e. science carried out in terms of the prevailing paradigm is increasingly challenged by anomalies that are inconsistent with the assumptions and established findings of the discipline at that time. The growth in anomalies eventually gives way to a crisis in the discipline. The period of revolution is resolved when a new paradigm emerges as the ascendant one, and a new period of normal science sets in. Kuhn (1962, p.13) went on to label the natural sciences “paradigmatic” and the social sciences pre-paradigmatic”.

Kuhn’ s (1962) work resulted in various studies, one of them being by Biglan (1973a;1973b) who proposed the need to find a dimension that distinguishes paradigmatic and non-paradigmatic disciplines; and a second dimension, in which scholars perceive a discipline in terms of its requirements for practical application. To achieve this, Biglan (1973a, p.195) surveyed 168 academics from thirty-six disciplines at a US university, and 56 academics from thirty disciplines at a small US college to “make judgements about the similarities of different subject matter”. This study culminated in Biglan (1973a) identifying a total of three dimensions that characterise the subject matter of academic disciplines in most institutions; (a) the degree to which a clearly delineated paradigm exists - *hard* versus *soft* disciplines, (b) the extent of concern with the practical application of the subject matter, *pure* versus *applied* disciplines, and (c) the level of involvement with living or organic objects of study - *life system* versus *nonlife system* disciplines. Biglan (1973b) sought to use the three dimensions above to investigate the relationships between subject matter characteristics and the structure and output of university departments. Biglan (1973b) used three factors; *social connectedness* of scholars – meaning, academics may be socially connected to one another because they like each other, influence each other, or because they collaborate together; *commitment preferences* to academic tasks such as teaching, research, administration etc., and the *scholarly output* produced in the respective three dimensions. The findings from Biglan (1973b), together with an explanation of each of the three dimensions as identified in Biglan's (1973a) study above, are discussed below:

2.3.3.1. Hard versus Soft disciplines

Biglan (1973a, pp.201-202) used the term "hard" to distinguish those disciplines (for example, chemistry) that subscribe to a single body of theory (the paradigm), from "soft" disciplines in which content and method tends to be rather idiosyncratic, such as history. Biglan (1973b, p.210) identified the paradigm as permitting greater social connectedness among scholars, particularly on their research. In other words, Biglan (1973b) argued that generally, the nature of the tasks (for example, pooling of equipment, funding etc.) undertaken by scholars in hard disciplines necessitate collaboration more than those in soft disciplines. Moreover, much akin to the urban lifestyles identified by Becher (1989), scholars in hard disciplines tend to have more sources of influence on their research goals and a significant number of co-authors than those in soft disciplines.

In terms of preferences of academic tasks, Biglan (1973b, p.208) found that scholars in soft disciplines indicated a preference of teaching to research, whereas the reverse was true for those in hard disciplines. Moreover, relating to scholarly output, scholars in hard disciplines produced significantly fewer monographs than those in soft areas, but produced more journals articles. Biglan

(1973b, p.211) attributed this to the notion that, in hard disciplines it is not necessary to provide detailed descriptions of the content and method that underlie a piece of research as these are understood by anyone familiar with the paradigm; journal articles therefore, with their restrictions on length provide an appropriate means of communication. Conversely, in soft disciplines, where paradigms are not characteristic, the scholars must (i) describe and justify the assumptions on which their work is based, (ii) delimit their method or approach to the problem, (iii) and establish criteria for their own response to the research problem - more space than that available in journals will be required to accommodate this. This observation is particularly important to note as it helps to explain one of the responses to the Finch Report (2012) in section 2.1.6.11 whereby the Royal Historical Society (2012) argues that no OA business model as yet has been devised for the large part of humanities publications disseminated in the form of monographs and edited collections rather than journal articles. Moreover, it helps lay the foundation in understanding the concerns of academics in soft disciplines feeling the "pressure to publish" in channels compatible with hard disciplines such as journals, for research evaluation purposes. This issue is discussed further in section 2.3.5.2.

2.3.3.2. Pure versus Applied disciplines

Biglan (1973a, p.202) used the label pure-applied to identify the way scholars view academic disciplines in terms of application to practical problems. He distinguished applied disciplines such as education, engineering, agricultural sciences from pure disciplines in the physical sciences, social sciences and humanities. Biglan (1973b, p.209) found that the nature of tasks undertaken by scholars in applied disciplines necessitates them to work with more people than those in pure disciplines, and they reported more sources of influence on their research (many of these sources of influence being external agents such as businesses) than those in pure disciplines. He attributed this to the emphasis on the practical value of scholars in applied disciplines, which led them to rely more on the validation of others.

In terms of academic task preference, Biglan (1973b, p.209) identified scholars in applied disciplines as preferring to research with more people than in pure disciplines. The study also revealed an association between pure-applied and hard-soft categories and the number of sources of influence for research goals. It showed that the difference between pure and applied disciplines on this variable was larger for hard disciplines (e.g. chemistry vs. engineering) than it was for soft areas (e.g. education vs. history).

In relation to scholarly output, Biglan (1973b, p.211) noticed that scholars in applied disciplines published more technical reports than those in pure disciplines. He suggested that this could be due to technical reports providing an ideal format for communicating detailed research results to the internal or external groups and individuals who were serviced by scholars in applied disciplines. Moreover, monograph publication depended more on social connectedness (i.e. academics being socially connected to one another because they like each other, influence each other, or because they collaborate together) in pure disciplines than in applied disciplines where social connectedness made no difference.

2.3.3.3. Life system versus Non-life System disciplines

As briefly indicated above, Biglan (1973a) initially set to study the two dimensions discussed above, but found there to be another dimension looking at the level of involvement with living or organic objects of study. The term "life system discipline" was used by Biglan (1973a) to refer for those disciplines such as botany and entomology with a high level of involvement with living objects; with the term "non-life system disciplines" referring to the rest of disciplines that are not involved with living objects. Biglan (1973b, p.209) found that scholars in life system disciplines reported significantly more sources of influence on their research goals than did scholars in non-life system disciplines. Moreover, though differing significantly in academic tasks such as teaching i.e. scholars in life-system disciplines preferring to teach less than those in non-life disciplines, there were no differences in terms of research activities. Biglan (1973b, p.210) also found there to be no significant differences between scholarly output in life system and non-life areas.

The interactions between the three dimensions above led Biglan (1973b) to formulate a classification system indentifying eight groupings of disciplines as shown in Table 2-2 below:

Table 2-2: Groupings of academic disciplines according to Biglan's three dimensions (Source: Biglan, 1973b, p.207)

Task area	Hard		Soft	
	Nonlife system	Life system	Nonlife system	Life system
Pure	Astronomy Chemistry Geology Math Physics	Botany Entomology Microbiology Physiology Zoology	English German History Philosophy Russian Communications	Anthropology Political science Psychology Sociology
Applied	Ceramic engineering Civil engineering Computer science Mechanical engineering	Agronomy Dairy science Horticulture Agricultural economics	Accounting Finance Economics	Educational administration and supervision Secondary and continuing education Special education Vocational and technical education

Biglan's (1973a; 1973b) work attracted a lot of attention from various scholars. Two of of them were Kolb (1981) and Becher (1987). Kolb (1981) and Becher (1987) questioned the significance of Biglan (1973a:1973b) third dimension – life systems versus non-life systems. They argued that it accounted for less variance than the other two dimensions in Biglan's (1973b) data. Kolb (1981) proposed his own discipline typology based on the learning styles of students - a departure from Biglan (1973a; 1973b) who had used academics in his study. Kolb (1981) categorised students' learning styles into two dimensions: concrete-abstract *(akin to hard-soft)* and active-reflective *(akin to pure-applied)* categories, these two dimensions resulted in four groupings; the *abstract-reflective* which consist of natural sciences and mathematics; *abstract/active* which consist of what Kolb (1981) termed 'science-based professions', such as engineering disciplines; *concrete/active* which consisted of 'social professions' such as education, social work and law; and *concrete-reflective* such as humanities and social sciences.

Becher (1987) acknowledged the significance of Biglan's (1973a; 1973b) and Kolb's (1981) work in their contribution to better understanding of disciplines, but stated that more needed to be explored about the nature of knowledge and cultural structures of disciplines. Becher's (1987) motivation for this was fuelled by his observation on what university administrators and previous scholars had done over the years; to cluster disciplines into groups which are then treated as homogeneous. He gave psychiatry as one example that is treated as a social science on the face of it, but within the discipline, as Becher (1987) observed, there is conflict over the biological (hard/pure) and psychological (soft/pure) basis of mental illness. Becher (1987), therefore interviewed 221 academics in twelve disciplines namely; biology, chemistry, economics, geography, history, law, mathematics, mechanical engineering, modern languages, pharmacy, physics and sociology with discussions based upon on six main topics: the structure of the subject, the nature of evidence, career patterns, criteria for professional recognition, aspects of professional practice, and costs and benefits of disciplinary membership. This result of this study was a typology of four discipline groupings as shown in Table 2-3 below;

Table 2-3: Becher's (1987) typology of knowledge and cultural structures in disciplines (adapted from Becher, 1987, p.289)

	Hard	Soft
Pure	Pure sciences *Knowledge structure* Cumulative; atomistic (crystalline/tree-like); concerned with universals, quantities, simplification; resulting in discovery/explanation. *Cultural structure* Competitive, gregarious; politically well organised; relatively high publication rate; task oriented. *Example discipline* Physics	Humanities and pure social sciences *Knowledge structure* Reiterative; holistic (organic/river-like); concerned with particulars, qualities, complication; resulting in understanding/interpretation. *Cultural structure* Individualistic, pluralistic; loosely structured; relatively low publication rate; person oriented. *Example disciplines* Humanities – History Pure social science - Anthropology
Applied	Technologies *Knowledge structure* Purposive, pragmatic (know-how via hard knowledge); concerned with mastery of physical environment; resulting in products and techniques. *Cultural structure* Entrepreneurial, cosmopolitan; dominated by professional values; patents can be substitutable for publications; role oriented. *Example discipline* Mechanical Engineeering	Applied Social Sciences *Knowledge structure* Functional, utilitarian (know-how via soft knowledge); concerned with enhancement of [semi-] professional practice; resulting in protocols and procedures. *Cultural structure* Outward looking; uncertain in status; dominated by intellectual fashions; publication rates reduced by consultancies; power oriented. *Example discipline* Education

Table 2-3 shows how Becher's (1987) typology was influenced (minus the life system/non-life system dimension) by Biglan's (1973b) typology above. Another visible difference is how Becher's (1987) typology is more detailed in characterising the knowledge structure and cultural structure of disciplines in the four quadrants. A mutually reinforcing relationship exists between the knowledge and cultural structures of disciplines shown above (Becher & Trowler, 2001, pp.23-24). In other words, while the epistemological structures (for example, the procedures required for enquiry or how findings are interpreted) of disciplines shape the academic behaviour of their 'inhabitants' (or academics), the inherent values and attitudes of the 'inhabitants', stemming from gender, ethnicity, social class, former workplaces etc. also shape their practices. Becher & Trowler (2001, p.24) argue that academics do not lose these values and attitudes "simply because of the power of the discipline".

Each of the quadrants is briefly explained below, as some of the general descriptions have been already highlighted in Biglan's (1973b) typology above.

2.3.3.4. Hard Pure (e.g. physics)

Becher (1987, p.280) argues that hard/pure disciplines are 'cumulative' in terms of their acquisition of knowledge. He gives an example of physics whereby each finding typically builds on previous ones in a linear progression, with major problems being subdivided into smaller segments and tackled piecemeal. Hence the structure of inquiry is "like a crystal" in that it grows by accretion and is neatly divisible (Becher, 1987, p.280). Becher & Kogan (1992, p.91) give an additional description of hard/pure disciplines and noted that they are more amenable to team work, sometimes on a large scale, sometimes on a small scale. Moreover in operational terms, Becher & Kogan (1992, p.91) also noted hard pure disciplines to be heavily dependent on physical resources, especially laboratories, supplies and instrumentation.

2.3.3.5. Soft Pure (e.g. history)

In contrast with hard pure disciplines; in soft pure disciplines, the same phenomena are examined by individual enquirers, each presenting individual findings (Becher, 1987, p.280). Hence the problems that form the starting points for most enquiries are multi-faceted and not easily divisible, in other words, the mode of investigation is organic rather than crystalline (Becher, 1987, p.280). As such, academic activity in soft/pure disciplines tends to be individual rather than collective, and although academic interest groups exist, they have in general neither the strength nor the prestige of those in hard pure fields (Becher & Kogan, 1992, p.91). Moreover, equipment demands tend to be negligible (Becher & Kogan, 1992, p.91).

2.3.3.6. Hard Applied (e.g. mechanical engineering)

Hard applied disciplines are associated with some of the characteristics of the hard pure disciplines; work in these disciplines will always have some practical end in view, therefore more emphasis is placed on products and techniques, rather than concepts and theories (Becher & Kogan, p.91). Moreover, as their primary outcomes are products and techniques, research in hard applied disciplines is typically judged based on purposive and pragmatic criteria (Becher, 1987, p.281). Also, operationally, the funding links with industry are likely to be stronger that the other three categories because of the functional nature of much of the research activity (Becher & Kogan, 1992, p.91).

2.3.3.7. Soft Applied (e.g. education)

By contrast to hard applied disciplines, soft applied disciplines are dependent on soft pure knowledge in achieving the improvement of professional practice. Moreover, soft applied disciplines use soft pure knowledge as a means of "understanding and coming to terms with the complexity of human situations, rather than as a way of explaining and mastering the material environment." Becher, 1987, p.281). Hence in such disciplines, there is typically no requirement for laboratory material (Becher & Kogan, 1992, p.91).

From this typology, Becher & Trowler (2001, p.39) argue that using departments to which scholars belong, to identify their dissemination and publishing behaviour, scholars fail to take into account that most individual disciplines, turn out to contain a diversity of research styles and epistemological characteristics. Becher & Trowler (2001, p.65) however point to a weakness in all discipline classification systems by stating that:

"There is no single method of enquiry, no standard verification procedure, no definitive set of concepts that uniquely characterises each particular discipline." Becher & Trowler (2001, p.65).

The overarching conclusion regarding all the discussions above on the social and intellectual elements in disciplines, as Fry (2004) observed is that; intellectual fields within a single discipline can vary to a great extent, and a given intellectual field may have more in common with an intellectual field in another discipline than its own parent discipline. In his research on OA advocacy Kingsley (2008, p.211) adds that merely identifying differences between disciplines may not be enough to determine successful ways of advocating for IR use, as disciplines themselves encompass a series of sub-specialisms. Economics is one example that helps in illustrating Fry's (2004) and Kingsley's (2008) assertion, in that; scholarly behaviour, both in terms of publishing frequency and the channel used for research dissemination is not uniform across a single discipline. As observed by Harley *et al*. (2010, p.321) applied economists spend more time collecting original data and consequently may publish articles less frequently than theoretical economists who rely on secondary data and tend to publish more often. Moreover, in terms of dissemination behaviour, articles seem to be more prevalent for more quantitative topics of economics, whilst books seem to be important for the more qualitative topics such as the history of economic ideas (Antelman, 2006, p.84).

The above discussion has focused on how the sociological and epistemological elements of disciplines influence scholarly dissemination and publishing behaviour. Sections 2.3.4 and 2.3.5. below will look at the closely related area of how institutional policies such OA mandates enacted by institutions such as universities and research funders, and research evaluation mechanisms enacted by the government influence scholarly publishing and dissemination behaviour.

2.3.4. The influence of OA mandates on publishing behaviour

OA mandates enacted by universities or research funders can to a large extent influence scholarly publishing and dissemination behaviour.

2.3.4.1. OA Mandates

OA mandates can be enforced by an institution or research funder so as to increase the open availability of scholarly outputs, the range of mandated outputs may vary depending on the institution/funder, but almost always includes journal articles.

2.3.4.2. Institutional and sub-institutional level mandates

In a bid to increase the visibility of their research output, higher education institutions have sought to change the scholarly behaviour of their employees by enacting OA mandates. Such mandates are based on the requirement or request for deposition of various research outputs into the institutional repositories.

While some institutions have their mandates set at the institutional level i.e. all faculties/schools/departments are bound to one mandate, at some institutions mandates are set at sub-institutional level i.e. specific to a particular department/school/faculty or departmental. Xia *et al*. (2012, p.100) argues that the ”one size fits all” approach of institutional mandates is ineffective and that there is need for adopting sub-institutional level mandates that take into account the needs of specific groups. This is in concert with the above discussion that different disciplines have different epistemological and sociological structures, therefore different needs. A well-documented example of the development of sub-institutional level mandates is one at Harvard University in the US (Suber, 2008d; Krausse, 2009; Brand, 2012). Harvard University’s Faculty of Art and Sciences announced an OA mandate in February 2008, followed by Harvard Law School in May 2008; almost a year later, in March 2009, the School of Government announced its own mandate and the other faculties followed (Krausse, 2009). As of 2011, nine of the University’s faculties had enacted their own mandates (Brand, 2012, p.29). Suber (2008c) attributes the success of the Faculty of Arts and Science in initiating the first of any mandate at the University to advocacy spearheaded by a computer science professor in the faculty (Suber, 2008d). Below is a discussion on the challenges likely to be faced in advocating for faculty-level or institutional mandate.

Advocates for institutional level mandates argue that they expand access to the scholarship produced at an institution, and benefits scholars outside the institution (Brand, 2012, p.32). However, the difficulties in implementing them have been noted by Xia *et al*. (2012, p.87) who suggests that: firstly, scholars’ willingness to comply with a policy may not be translated into action; in other words, in some institutions, there is much more support for OA in theory rather than in practice. Secondly, the effectiveness of mandates is difficult to evaluate; an increased rate of self-archiving in an IR may be because of reasons other than the adoption of a policy (Xia *et al*. 2012, p.87). Another issue relates to the challenge of changing the behaviour of researchers; the presence of other self-archiving channels such as personal websites and subject-based repositories which have been culturally embedded in particular disciplines, make advocacy for institutional mandates difficult (Brand, 2012, p. 32).

The cultural and applicability barriers mentioned above raise the question of the effectiveness of mandates, in other words, to what degree are researchers willing to comply with mandates? In a survey by Swan & Brown (2004), when asked how they would feel if their employer or funding body required them to deposit copies of their published articles in IRs, 83 per cent of researchers responded that they would do so willingly, while 4 per cent would do so, but unwillingly. However, it should be noted that the 83 per cent figure combines the attitude towards a mandate enacted by *either* an institution or a funding body, given that there is a possibility that attitudes to funder mandates could differ from those towards institutions.

2.3.4.3. Funder mandates

Funder mandates also play a huge role in how scholarly literature is disseminated. Funder mandates have three main differences to institutional and sub-institutional-level mandates; a) the target population of the mandates covers all who are responsible for project funding, these researchers do not necessarily have to be academics in a university setting; b) most require deposit within a time frame, usually between six to twelve months; c) some funders specify deposit into a specified repository such as PMC, while others encourage deposit in a repository of choice (Xia*et al.*2012, pp.95-96).

There has been a considerable push by OA advocates for example - Harnad *et al.* (2003); Suber (2008); Harnad (2008; 2013), for authors to self-archive their post-prints in their IRs rather than funder repositories. Suber (2008d), responding to the newly announced NIH OA mandate in 2008 stated that, it would be better for optimal OA, if NIH’s stipulated locus for the direct deposit of funded research were the grantee’s own IR (from which the deposit could be harvested by PMC). This would;

"…help enormously to integrate and universalise all green OA self-archiving mandates, from universities as well as funders … in a convergent mutually reinforcing synergy." (Suber, 2008e, n.p.).

Five years earlier, Harnad *et al*. (2003) had seen the potential of IRs being "research performance databases that could be driven by an RAE mandate for self-archiving in them". They argued that, if HEFCE required that all RAE-assessed scholarly literature be deposited in IRs, then HEIs would follow suit by enacting institutional mandates, which would help reinforce and monitor compliance with funder mandates. Harnad *et al*. (2003) asserted that there was great compatibility between IRs and research evaluation mechanisms in that IRs would allow full-text peer-reviewed articles to be *continuously accessible* while also being assessable for research performance. This argument was further elaborated by Harnad (2008, n.p.);

"University mandates are the obvious means of reinforcing and monitoring compliance with funder mandates (as part of the fulfilment conditions for receiving the grant overheads and indirect costs allotments). Moreover, university IRs are also the natural, convergent locus for direct deposit of all research output: The universities … have a direct institutional interest in archiving, recording, measuring, evaluating, and showcasing their own research output as well as in maximizing its uptake, usage and impact."

As one of the scholars invited to give evidence by the House of Lords Business, Innovation and Skills Select Committee in its review of the RCUK OA policy in light on the Finch Report (2012), Harnad (2013) suggested that the idea above (Harnad, 2008) could be operationalised in the following way; there should be immediate-deposit of the final peer-reviewed draft by the author *into his/her IR (not the funder repository)*, so that it can be monitored and verified by the author's institution, *regardless* of whether the mandate is from a funder or the institution. Although the deposit must be immediate, access to the deposit may be embargoed, the immediate deposit serves to provide metadata that can be used for research assessment purposes.

“The IR must be designated as the sole mechanism for submitting publications for institutional performance evaluation, research grant applications and REF”. (Harnad, 2013, n.p.).

It seems such advocacy has shaped UK open access policy. In February 2013, HEFCE began consulting academics and policy makers on the role of OA in subsequent REFs. Following this consultation phase, in March 2014 HEFCE adopted the following policy:

“…to be eligible for submission to the post-2014 REF, outputs must have been deposited in an institutional or subject repository on acceptance for publication, and made open-access within a specified time period.” (HEFCE, 2014, n.p.)

HEFCE (2014) also confirmed that the policy would only apply to journal articles and conference proceedings; whereas books, book chapters, research data, and creative and practice-based research outputs were deemed “out of scope”.

2.3.5. The influence of research evaluation mechanisms on scholarly behaviour

There is evidence (RIN, 2008, p.25) of research evaluation mechanisms such as the Research Assessment Exercise (RAE) influencing researchers’ behaviour in terms of how they produce and disseminate their research outputs. Because the RAE was perceived to value, above all else the publication of papers in high-impact journals, most researchers focused their efforts on such publication. The reward and recognition principles of research, on which research evaluation mechanisms are based make the pressure to publish, to compete for and win grant funding, and to repeat the cycle, strong and persistent, as researchers’ career trajectories largely depend on their success in these activities (RIN, 2008, p.25).

Donovan (2007, p.539) notes that a “push-pull” relationship exists between government and academia, whereby there is a “push” by government towards research performance evaluation, yet there is “pull” by academics towards autonomy or academic freedom.

2.3.5.1. Academic freedom/autonomy

Academic freedom/autonomy entails being;

"individually free to choose and pursue one's own research agenda and being trusted to manage the pattern of one's own working life and priorities." (Henkel, 2005, p.169).

Autonomy is likely to be prevalent in highly rated departments, which have more confidence in giving staff freedom to explore research areas of interest (McNay, 2007). This is in contrast with the lowest rated departments, which are characterised by limited leverage on resources; hence staff "may be grateful for any work, often done in private time on top of a heavy teaching load." (McNay, 2007). McNay (2007, p.211) classified social science scholars into four categories (the oppressed, the assertive, the independent, and the positive) in terms of the degree to which RAE had affected their academic autonomy. *The oppressed* are driven by the requirements of senior colleagues, usually in high-rated departments; *the assertive* pursue their own agenda anyway, often in a low rated department that is grateful for anything, but not supportive to its staff; *the independent/entrepreneurial* have generated their own income against their own agenda, and so are able to resist pressure where it exists; *the positive* have welcomed the pressure from the RAE, which has not spilled over into stress.

McNay (2007, p.211) also identified that the RAE has an effect on decisions about what research to pursue and within what methodological paradigms – this operates at three levels; system level, institutional level, and individual level. At *system level* there is lack of clarity about definitions, processes and criteria, creating uncertainty, thereby leading to a conservative, low-risk, and mainstream activity in research. At *institutional level* there is often emphasis on RAE relevant activity at the expense of other work and publications that would have more impact on practice beyond the academic community (McNay, 2007). As a consequence, at the *individual level* staff may then pursue survival and self-interest strategies (McNay, 2007, p.211). One of these strategies is practice of the "least publishable unit".

2.3.5.2. "Pressure to publish" and academics' "survival strategies"

A euphemism - the "least publishable unit" was used by Wheeler (1989) to characterise the result of fragmenting data in order to produce the greatest possible number of publications. Describing the influence the department and the institution have on scholarly behaviour, Wheeler (1989, n.p.) asserts that;

"*Researchers are under so much pressure to publish research papers and the motive behind it is clear. More papers mean more prestige for a researcher's department—and the prestige will translate, department heads hope, into more financial support from the university."*

The first RAE in 1986 used the number of refereed publications as its main indicator, and the result was the prevalent practice of the "least publishable unit" by scholars so as to increase their number of publications (Elton, 2000, p.276). In art history for example, where the monograph is the main form of communication, some researchers may decide to break a manuscript into parts and publish a series of articles dispersed in different journals over time (Ballon & Westermann, 2006, p.43). This has the effect of making it difficult for readers to follow the thread of the argument, and in other cases, the scale of thinking might shrink if authors cannot publish a full-scale argument (Ballon & Westermann, 2006, p.43). However, it is noteworthy that, practice of the least publishable unit is not only attributed to the RAE, but also to publishers' actions through imposing constraining word limits. Publishers of *Nature* and *Science* have been criticised for eliminating detailed discussions of methods and room for deeper arguments through their imposition of constraining word limits (Harley *et al.* 2010, p.12).

Researchers from a variety of disciplines in the sciences interviewed by Sparks, *et al*. (2005) for example, felt they were under pressure from RAE requirements to publish a certain number of publications in reputable journals. One respondent interviewed by McNay (2007) stated that this "pressure to publish" came at the expense of high quality research which often requires significant time for reflection, and it also creates a skewed relationship between the production of research and the process of disseminating findings. Moreover, separate studies by Jones *et al.* (2001) and Harley *et al*. (2010, p.37) revealed the pressure to publish on archaeology scholars led them to produce a "glut of books" which often did not fulfil the expected quality standards. One of the humanities scholars interviewed in a Research Information Network (RIN) study on the dissemination behaviour of UK researchers revealed that; "the pressure to produce a monograph (often regardless of quality) had increased greatly because of the RAE." (RIN, 2009, p.21).

Another form of this pressure to publish is related to the emphasis placed on particular research outputs. Computer science scholars interviewed by Sparks *et al.* (2005, p.65) revealed that they generally had a tendency of remembering information from meetings, conferences and workshops more than from journal articles, but they faced pressure in publishing in journals rather than conference proceedings. Moreover, an interview response from a social science researcher in the RIN (2009) report signified there was a growing pressure to publish in book chapters rather than in books because "a book with several contributors is easier to produce within the RAE cycle than a single author original work." (RIN, 2009, p.21). In addition, computer science and engineering scholars interviewed in the same study indicated that they were publishing less frequently in obscure and non-refereed conferences, partly as a result of the RAE, as one respondent stated:

"I have moved away from workshops and conferences because they are perceived in the RAE as not as good as peer-reviewed journals." (RIN, 2009, p.22).

This was despite 57 per cent of the computer science and engineering scholars surveyed (compared to 17 per cent in humanities) revealing that conferences were a "very important" channel for research dissemination (RIN, 2009, p.21).

2.3.5.3. Evaluating socio-economic impact

While citation data can provide information about the academic significance of an article, it does not necessarily provide evidence of research "impact" as defined for the purposes of REF 2014 (Nightingale & Marshall, 2012, p.61). HEFCE (2011a, p.48) defines socio-economic impact as;

"an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia".

In the UK, concerns about the REF have been voiced by the academic community. For example, there have been concerns that the academic prestige of publications being targeted at audiences beyond the academic and research communities, where citations are not normally needed or expected, will be downgraded (RIN, 2009, p.47). Moreover, the REF impact measurement is very broad and diverse, and institutions are faced with the challenge of capturing all socio-economic impact of their research activities and to be able to evidence the outcomes (Scoble, 2010, p.503). Socio-economic impact is difficult to assess in terms of isolating cause and effect relationships which may only be visible beyond the timeframe within which the reports have to be submitted for peer evaluation (McNay, 2010, p.308).

The disciplinary issues regarding the measurement and assessment of impact in REF 2014 were acknowledged by HEFCE (2011b). One of the issues highlighted was in regards to some research in the arts and humanities which has cultural or quality of life benefits, these (benefits) tend to diffuse or be less tangible and hence more subjective or difficult to evidence. HEFCE, however, stated that it had confidence in REF's discipline-based peer review method, which is founded upon expert judgement (HEFCE, 2011b). Section 4.4 discusses this issue of impact in more detail.

4.3.6. Summary

Researchers are part of a social system in which their behaviour is influenced by norms, and the degree of competition is apparent across disciplines. A researcher's department and institution also play a major role in determining how researchers produce and disseminate their results. Moreover, research evaluation mechanisms such as RAE/REF influence scholarly behaviour. Research impact, which has been discussed above, will be discussed in the next section in more detail.

2.4. RESEARCH IMPACT

2.4.1. Introduction

This final section of the literature review explores the concept of research impact in more detail. It has been discussed in preceding sections the possible impacts open availability of data to researchers could have on them both as creators and users of research. Moreover, it has been discussed how scholarly behaviour in different disciplines is influenced by research evaluation mechanisms such as the RAE/REF. It follows then, to explore the meaning of research impact the issues regarding how it can be evaluated, the methods used in evaluating this research impact, identifying the difficulties of evaluating it.

2.4.2. Defining research impact

The London School of Economics (LSE) Public Policy Group's *Impact Handbook* defines research impact as a:

> "*recorded or otherwise auditable occasion of influence from academic research on another actor or organization." (LSE Public Policy Group, 2011, p.21).*

Another definition is given by Beacham, Kalucy & McIntyre (2005, p.3) who define research impact as the effects and outcomes, in terms of value and benefit, associated with the use of knowledge produced through research. Both definitions point to three key points 'influence', 'effect' and 'outcomes' of research, both within and outside the academic community.

Research impact exists in the form of *academic impact,* in which research has influences upon actors in academia or universities, as measured by citation count for example, or esteem indicators such as journal editorship, as assessed by expert peer review panels. On the other hand, *non-academic impacts* are influences on actors outside the academic environment, i.e. in business, government or civil society, as measured by for example, references in the trade press or in government documents, or by coverage in mass media (LSE Public Policy Group, 2011, p.21). De Campos (2011) identifies non-academic impacts under three categories: economic impacts; social-cultural impacts; and policy, practice and environmental impacts. For the purposes of the REF, HEFCE (2011a, p.26) identified a range of categories and defined 'impact' as:

"*an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia"*

HEFCE (2011a, p.26) went on to specify what this definition included and excluded: "Impact includes, but is not limited to, an effect on, change or benefit to:

- *the activity, attitude, awareness, behaviour, capacity, opportunity, performance, policy, practice, process or understanding*
- *of an audience, beneficiary, community, constituency, organisation or individuals*
- *in any geographic location whether locally, regionally, nationally or internationally.*

'Impact' however excludes "impacts on research or the advancement of academic knowledge within the higher education sector (whether in the UK or internationally)" Unlike HEFCE (2011a), other international research funders including the US National Science Foundation (NSF, 2012) and Australian Research Council (ARC, 2012b) have used the term; 'broader impacts' to describe non-academic impacts. Therefore, in this literature review, both phrases – 'impact' and 'broader impact' will be used interchangeably except where it is necessary to specify a particular impact, for example policy impact or economic impact.

2.4.2.1 The relationship between academic impact and broader impact

LSE Public Policy Group (2011, p.8) argue that academic credibility has an influence of how research makes an impact outside the academic community. Academic credibility is established through academic impact; for example, by publishing in high impact journals, citation rates, making keynote speeches at international conferences and editorship of high prestige journals. Researchers who are well respected and have attained a senior standing within the university are more likely to be invited to write publications and review books for the general public than other academic staff (Levitt *et al*. 2010, p.32).

Research recognised as being of high quality within the academic community, however, does not necessarily imply that it will have considerable broader impact. This is due to the existence of “multipliers” such as policy-making bodies, businesses and consumers etc. which have the potential to not only multiply, but also limit impact (PA Consulting & SQW Consulting, 2007, p.36). Lettice *et al*. (2012) gives an example of how the impact of climate change research can be limited by “carbon lock-in” (Unruh, 2000, p.817) which arises due to a combination of systemic forces such as technology and societal institutions that prevent adoption of innovations by industrialised economies. This thereby perpetuates industrialised economies’ reliance on fossil fuel-based energy and transportation systems in spite of their known environmental damage.

Research impact is strongly influenced by the ability and willingness of businesses and policy-making bodies to convert research outputs into products, processes and policies of value to society. Ignoring the effects of multipliers is often termed “project fallacy” (Georghiou, 2002, p.61). “Project fallacy” occurs when the potential impacts of a project are overstated, and consequently fail (or delay) to materialise due to researchers assuming that the *intended impacts* of the project are the same as its *realised impacts* (PA Consulting & SQW Consulting, 2007, p.36). A classic example of project fallacy is the case of the original work on apoptosis (programmed cell death) whereby scientists had hoped that due to the high quality and novelty of the discovery, the work would make an immediate impact on health care. It transpired that thirty years after apoptosis was discovered, there still had been no measurable societal impact (Smith, 2001, p.528).

2.4.3. Emphasis on evaluating broader impacts in the UK

The reasoning behind the emphasis on evaluating broader impacts in the UK is complex, involving both political and socio-economic factors (Penfield *et al*. 2014, p.22). The rationale behind research evaluation, as articulated by the Higher Education Funding Council of England (2011) is based on three primary purposes: to inform *allocation* of research funding to universities; to provide *accountability* for public investment in research; and to provide *benchmarking* information and establish reputational yardsticks. From this, it can be deduced that the government’s position is that by funding ‘excellent’ research, impacts that are beneficial to not only the academic community but society as a whole will transpire. The next three paragraphs and Table 2-4 below give some background on how broader impacts became embedded as a criterion for research evaluation in the UK.

In a report authored jointly by HM Treasury (HMT), Department for Education & Skills (DfES), and the Department for Trade & Investment (DTI), titled *Science and Innovation Investment Framework (SIIF 2004-2014),* the UK government set its vision on the need to apply research beyond the academic community, in order to drive economic growth. The report stated that for the UK economy to succeed in generating growth through productivity and employment, it had to invest more strongly than in the past in its knowledge base, and *translate* this knowledge more effectively into business and public service innovation (HMT, DfES & DTI, 2004, p.5). Two years later, in 2006, the *Warry Report*, commissioned by the DTI to evaluate how UK’s research councils could drive the nation’s innovation agenda, recommended the UK government to demonstrate the economic impact of publicly funded research, thereby calling for research councils to “ensure that economic impact is given a high profile in council strategy.” (Warry *et al.* 2006, p.3). This recommendation was emphasised again in the *Sainsbury Review* in 2007. The *Sainsbury Review* was commissioned by HMT in order to review the science and innovation policies that had been put in place by the government since the *SIIF 2004-2014* report. The *Sainsbury Review* stated the importance of application of publicly-funded research in a “national innovation ecosystem” in a bid for the UK to be competitive on the world stage (Sainsbury, 2007, p.4).

Following the *Warry Report* (2006) and *Sainsbury Review* (2007), government agencies such as HEFCE and RCUK began formulating strategies prioritising broader impacts. In 2008, HEFCE published guidelines emphasising the influence of one of its initiatives - the Higher Education Innovation Fund (HEIF) - on economic and societal benefits in the UK, gained through developing and undertaking a broad range of knowledge transfer activities (HEFCE, 2008, p.4). Thereafter, in 2009, RCUK introduced “Pathways to Impact” (formerly known as Impact Plans), namely: policy, business, voluntary and charitable, and public engagement, as indicators for evaluating broader impacts (RCUK, 2013, p.10). RCUK's motto of "Excellence with Impact" shows its commitment to promoting research beyond the academic community. In addition, HEFCE has already confirmed that the 20 per cent weighting allocation for impact (alongside 65 per cent for *outputs* and 15 per cent for research *environment*) will increase in future REFs (HEFCE, 2011c). The *Witty Review* (2013) a report on the role of UK universities in facilitating economic growth has recommended that this impact weighting be increased to 25 per cent (Witty, 2013, p.9) in the next REF.

The events above are summarised in Table 2-4 below:

Table 2-4: REF – key milestones

Date	Event
2004	Science and Innovation Investment Framework (SIIF 2004-2014)
2006	Warry Report
2007	Sainsbury Review
2008	Higher Education Innovation Fund (HEIF) report
2009	HEFCE commissions RAND Corporation to review international practice for assessing research impact
2010 (March)	Publication of 'Initial decisions' by the funding bodies on the conduct of the REF
*****2010 (November)	Publication of reports on the REF impact pilot exercise
*****2011	Publication of 'Decisions on assessing research impact'
*****2012	Publication of 'Panel criteria and working methods'
2013	Witty Review
*****2013 (November)	Closing date of submissions
*****2013 (December)	End of publication period (cut-off point for publication of research outputs, and for outputs underpinning impact case studies)
*****2014	Publication of outcomes
*****2015 (Spring)	Publication of submissions, panel overview reports and sub-profiles

*Events with * were sourced from HEFCE (n.d.).*

Table 2-4 illustrates that HEFCE implemented a pilot exercise to how workable this broader impacts criterion will be, this is discussed in more detail in section together with methods of evaluating broader impacts.

The introduction of the broader impacts criteria in research evaluation was met with opposition from some sections of the academic community. There were concerns by some academics, as noted by Penfield *et al*. (2014, p.23) that the broader impacts criterion would add an administrative burden and would steer research towards disciplines and topics in which impact is more easily evidenced, thereby subsequently diminishing the importance of basic (or 'blue skies') research and threatening "the imaginative and creative quest for knowledge". In addition, there is a possibility, as noted by Watermeyer (2012a, p.125) that those disciplines more aligned to evidencing economic impact will be highly regarded in terms of their overall societal contribution, at the expense of those evidencing non-economic elements such as societal well-being or cultural enrichment. Other concerns relate to the emergence of an 'impact gap' (Watermeyer, 2014, p.370) whereby early-career researchers, as a result of limited experience in interactions with policy and practitioner groups, they become marginalised. Hartwell, van Teijlingen, & Parker (2013, p.77), however, see a positive outcome from REF in that researchers will be supported by their institutions when trying to make their work relevant to society.

UK's emphasis on broader impacts in research evaluation can be compared with the initiatives in other countries such as Australia, New Zealand and the US, as discussed in 2.4.3.1 below:

2.4.3.1. An international comparison

In Australia, the Research Quality Framework (RQF) was announced in 2007 by the Australian Research Council (ARC) to include a panel assessing broader impacts of publicly funded research (Kalucy *et al*. 2009, p.19). RQF however, was replaced in 2008 by a new government, which introduced a new assessment framework, Excellence in Research Australia (ERA), with less focus on evaluating broader impacts (Kalucy *et al*. 2009, p.19). Indeed, both the *ERA 2012 Evaluation Handbook*, and *ERA 2012 National Report Overview* show that only academic impact, through citation impact and peer review (ARC, 2012a; ARC, 2012b), are used for research evaluation, with less emphasis being placed on broader impacts. This is evident in one of the excerpts from the ERA 2012 National Report Overview:

"The ERA Evaluation is focused on academic excellence and impact; however, the ERA data collection includes a rich evidence base for discussing broader research

impact, and the contribution of the higher education research sector beyond academic publishing" (ARC, 2012b, p.45).

In New Zealand's case, whilst, the Performance Based Research Fund (PBRF) assesses broader impacts of research, it does so under the broad category of *research output (*in contrast with the REF which has a separate category for broader impacts - with an allocated weighting of 20 percent). In the Performance Based Research Fund, research output consists of: rigour, logic, clarity, originality, intellectual significance, impact, applications, artistic merit – all of which carry a weighting of 70 per cent (Tertiary Education Commission, 2013, p.60). *Peer esteem* (15 per cent) and contribution to the *research environment* (15 per cent) make up the remaining 30 per cent weighting (TEC, 2013, p.105).

The case in the US is different to the three countries above, in that, the US does not have a national research assessment exercise. However, there are individual agencies both at the federal and state level, including the National Science Foundation (NSF), which is responsible for funding science, technology, engineering, and medicine research (NSF, 2012). Since January 2013, NSF requires grant applicants to include a list of up to five examples of how their research will make an impact outside the academic community (NSF, 2012, p.II-11).

2.4.4. Evaluating academic impact

Various citation-based metrics have been used to assess academic performance, some of these metrics are; number of citations, the journal impact factor, and the h-index. It is important to note however, that each of these metrics have several variants used for detailed measurement of particular aspects, but the discussion of such variants is beyond the scope of this literature review. The *number of citations* is the number of times a researcher or research paper is cited by others (Van Noorden, 2010, p.864). Although this method denotes the influence of one's research, it is difficult to compare between different fields or career stages (Van Noorden, 2010, p.864). The *h-index* attempts to measure both the productivity and impact of the published papers of a researcher; for example a researcher with an h-index of 50 has 50 publications each cited at least 50 times (Van

Noorden, 2010, p.864). *The journal impact factor* refers to the number of citations in a given year to the citable items in a journal during the two preceding years (Garfield, 1955). The journal impact factor is not intended to be a reflection on the quality of a researcher's output, but rather the quality of a publication (though it is accepted that publishing in a highly rated journal may well indirectly affect a researcher's profile).

These citation-based metrics can be compared with a more qualitative measure such as expert peer review. The expert review method is based on perceptions of well-informed experts about different quality dimensions of research production (Groot & Valderramma, 2006, p.1363). There is a distinction however, between expert peer review - which is a method used for research evaluation, and the traditional peer review as defined in section 4.1.2, which is used primarily to ensure the quality of the articles published within a journal are of an appropriate standard for that journal.

McNay, (2009) highlights the strengths and weaknesses of both citation-based metrics and expert review methods of research performance evaluation as shown in Table 2-5 below;

Table 2-5: Strengths and weaknesses of citation-based metrics and expert review (McNay, 2009, p.43)

	Citation-based Metrics	Expert Review
Strengths	-incentives to productivity and staff recruitment -clear criteria for reward systems	-the process can be related to different disciplines or professional fields with differing expectations and interpretations -quantitative data are not excluded
Weaknesses	-bias in the choice of metrics and weighting -discrimination against newer staff and those taking career breaks	-the collective prejudice of panel members, which may privilege work in certain fields and undervalue challenging and approaches -inconsistency across panels and over time

Expert review opens the possibility to include a wide variety of different quality aspects in the final judgment, taking into account the current position of the researchers, specific problems and opportunities they face and the researchers' current and future potential (Groot & Valderramma, 2006, p.1363). Nightingale & Marshall (2012, p.60) argue that while it is acknowledged that the number of citations do not necessarily correlate with article quality, a high number of citations for a particular article is suggestive of utility by other researchers and as such is one example of a measure of academic impact.

2.4.4.1. Applicability of citation-based metrics

Stark differences between the humanities and natural sciences have been noted in applying citation-based metrics. The humanities differ from the natural sciences, in that most humanities disciplines have a longer cited "half-life" of publications, and accrue a higher citation rate of older literature (Dolan, 2007, p.27). Tsay (1998, p.1283) notes "half-life" as a term borrowed from nuclear physics, that was first applied to scholarly literature by Burton & Kebler (1960, pp.18-19) as the length of time articles in a journal continue to be cited after publication. Also, in addition to the cited half-life, it has been argued that the *life-span* of influential work in the arts and humanities is thought to be longer than that in other disciplines (Dolan, 2007, p.27). Dolan (2007) notes the work of Glanzel & Schoepflin (1999) who studied the citation variations of twelve disciplines, and found that there was a stark difference between lowest average citation age and the highest average citation age of the disciplines. Medical sciences (medicine research and immunology) had average citation ages of 6.9 years and 7.9 years respectively, whereas, the disciplinary grouping consisting of 'history, philosophy of science and social sciences' was calculated to be 38.8 years (Glanzel & Schoepflin, 1999, p.41). However, psychology, a social science that was measured separately, was calculated to have a significantly lower average citation age of 11.4 years, compared with 'history, philosophy of science and social sciences', although it was still higher than the two medical sciences disciplines. It should be noted however, that the calculations for these average citation ages were carried out almost fifteen years ago, therefore pre-dating major developments in scholarly communication over the past decade, such as the advent of institutional repositories in 2002 (Ware, 2004, p.115), and the increased emphasis by institutions, research funders and the government in making scholarly literature more accessible.

Another major difference between humanities and social sciences, and natural sciences is the difference in publication channels. Whereas, it is widely regarded that journal articles are the primary outputs in natural sciences, the same is not the case with humanities and social sciences, whereby books and book chapters are very important channels of scholarly communication (Royal Netherlands Academy of Arts & Sciences, 2005; Dolan, 2007). The Royal Netherlands Academy of Arts & Sciences (2005, p.19) notes a study by Small (2005) who calculated that 61.3 per cent of the references in history and philosophy of sciences in a selected dataset, were to non-journal publications. This can be contrasted with the low percentage (0.9 per cent) in high energy physics of the number of cited items that were books, in a study by Small & Crane (1979, p.451). Small & Crane (1979) found comparatively higher percentages of book citations for the other disciplines considered in the study: psychology (14.5 per cent), economics (24.5 per cent) and sociology (39 per cent).

The differences in opinion on which method is most effective as the basis for conducting a research evaluation exercise is evident from examples of countries that have adopted either metrics only - Flanders (Belgium); or expert review only – Spain; or both - Australia (Hicks, 2012, p.256). In the UK, the RAE 2008, assessment was mainly based on expert-review based on three broad criteria; output, research environment and esteem. *Output* was assessed on the originality, significance and rigour of four publications submitted by each returned member of academic staff. The research *environment* assessed department's research achievements, such as research income and doctorate degrees awarded. *Esteem* indicators include journal editing, visiting professorships, translation of work into foreign languages. The weightings between these criteria differed according to units of assessment (UOA); for example, in the UOA consisting of arts and humanities disciplines such history, and art and design, the weighting made more emphasis on *output* (70 per cent), followed by research *environment* (20 per cent) then *esteem*, with 10 per cent (HEFCE, 2006a, p.20). In comparison; for the civil, electrical and chemical engineering UOA, *output* was allocated a 50 per cent weighting, with more emphasis on *esteem* (30 per cent) then research *environment* (20 per cent) (HEFCE, 2006b, p.19).

2.4.4.2. The emergence of alternative metrics

Whereas traditional metrics such as citation counts drawn from services such as Google Scholar and Scopus have been used to measure the academic impact of scholarly output, other metrics are now being used as a way of reflecting the attention a paper has received online. These alternative metrics or ‘altmetrics’ (Priem *et al*. 2010) include; the number of page views, PDF downloads, mentions in blogs, saves to reference managers, “likes” or shares on social media (Kwok, 2013, p.491). Altmetric scores take into account the number of people who have read or mentioned the article, as well as the relative importance of the medium; hence, newspaper coverage is weighted more heavily than tweets, and tweets by individuals more heavily than those by journals promoting their content (Kwok, 2013, p.492).

There are issues surrounding use of altmetrics however, these include whether for example, a Facebook ‘like’ or a ‘share’ of an article amounts to impact. Indeed, this has been highlighted by Cheung (2013, p.176) who asserts that although altmetrics may provide insight into how such research outputs have influenced the academic community and the public, they lack authority and credibility as a performance measure, and also because it is easy to cheat by an individual creating multiple social media accounts. The other issue concerns the adoption of social media by researchers. Proctor *et al.* (2010), Nicholas & Rowlands (2011) and Jamali (2014), for example, found ‘lack of time’, due to other academic commitments including teaching, research and administrative duties as a major barrier for researchers adopting social media in their research activities. Despite the issues stated above, almetrics service providers continue to grow - to date there are four main atlmetrics services that provide altmetric reports, these are; *ImpactStory, Altmetric, Plum Analytics,* and *PLOS Article-Level Metrics.* These services measure a range of different types of research outputs including journal articles, datasets, software, patents etc. (Kwok, 2013, p.492). It would, therefore, be interesting to investigate the views of researchers on their use of social media and their awareness and attitudes towards altmetrics.

2.4.5. Measuring broader impacts

Measuring economic and societal impact of research is faced with many challenges. It has been argued though that outputs from the arts, such as performances and art exhibitions for example, make an impact on society by enriching our understanding of our own lives, firing our imaginations and ultimately making us happy (AHRC, 2009, p.5). It is not clear however how such happiness can be captured and measured.

Although acknowledging the difficulty of evaluating economic and societal impact in the Arts and Humanities, Evans (2013) gives instances of how this is feasible. For example, for the field of Applied ethics, the contributions by philosophers to the Leveson Inquiry's debate (2011-2012) on balancing press freedom with the right to privacy, can be regarded as philosophers applying their knowledge (through research) for the public benefit. Evans (2013) also points to resources such as *History and Policy,* an online publication about the application of history to public policy – citations from such a resource can be used as an indication of policy impact.

2.4.5.1. Broader impacts methods and indicators

De Campos (2011) identified a range of both quantitative and qualitative methods used to measure economic and societal impacts of research. Some of these include: econometrics, surveys and case studies.

De Campos (2011) asserts that one of the methods most suitable for measuring economic impacts is econometrics. Econometrics entails the use of various techniques such the Internal Rate of Return (IRR). IRR is the rate of growth a project is expected to generate; therefore, an IRR of 10% means that the return to an investment of £1 is equivalent to receiving thereafter an income stream of £0.10 per year in perpetuity (Health Economics Research Group, 2008, p.42). The IRR has been used for example, in a study to calculate the value of health gains from specific interventions to treatment or prevention of cardio-vascular disease over a twenty-year period (1985-2005), and the health-care costs incurred in the achievement of these gains (Health Economics Research Group, 2008, p.42). IRR *(as a measure of return on investment)* was calculated together with citation counts *(as a measure of impact of cardio-vascular disease research in formulating clinical guidelines)* of medical literature to come up with estimations of Quality Adjusted Life Years (QALYS) - a measurement used in assessing the value for money of a medical intervention (Health Economics Research Group, 2008, p.42).

The perceived strengths of econometrics are the simplicity of their use for monitoring and benchmarking. Econometrics techniques also offer consistency because they are independent of people's opinions and bias. Despite these strengths they are difficult to operationalise as they are heavily dependent on data, and are only effective if the right data collection strategies have been put in place (Jones, 2011).

Survey techniques, which make less use of economic and financial variables as compared to econometrics, can also be used as an alternative (De Campos, 2011). Buxton *et al*. (2000, p.32) on the other hand, argue that although survey techniques are useful, they only portray a "broad-brush picture" of the economic and societal impact of research projects. Buxton *et al.* (2000, p.32) assert that case studies instead, provide the best opportunity of capturing broader impacts of research projects. Indeed, case studies have been used in many studies ranging from capturing impacts in health care research (Kalucy *et al.* 2009); to arts and humanities (Levitt *et al.* (2010), and they have also been adopted by HEFCE for the REF 2014.

In 2009, HEFCE undertook a pilot exercise to test the appropriateness of case studies as a method for research evaluation. The pilot study consisted of 29 UK HEIs and concentrated on five areas; Clinical Medicine, Earth Systems and Environmental Sciences, English Language and Literature, Physics and Social Work and Social Policy. In 2010, HEFCE reported that case studies were capable of capturing the information that would be required for evaluation by expert panels, based on the 'reach' (how *widely* the research was felt) and 'significance' (how much *difference* it made to beneficiaries) criteria (HEFCE, 2011b, p.3). HEFCE (2011b) used 'reach' and 'signficance' as they sought to distinguish the two concepts of dissemination and research impact - in that, while dissemination can lead to 'reach', it, on its own cannot lead to impact as defined by HEFCE if there is no evidence of how much a difference (through dissemination) that research has made to beneficiaries, in other words, the 'significance' of that research.

One issue with using impact case studies is that they are often undertaken long after the research has been undertaken hence making the causal link between the research and the impacts difficult to ascertain (this issue is discussed in more detail in section 4.4.6). Despite this problem, certain impact indicator frameworks, to be used in conjunction with case studies have been proposed below.

2.4.5.2. Broader impact indicator frameworks

A widely documented framework for evaluating research impact is the Buxton & Hanney (1994) Payback Framework (Wooding, 2007; Kalucy *et al.* 2009; Levitt *et al*. 2010; Scott *et al*. 2011). The framework, originally developed for evaluating the socio-economic impact of health and medical research, has been adapted by others and applied to evaluate for example, research in the social sciences (Wooding, 2007) and arts and humanities (Levitt *et al.* 2010).

The Payback Framework was devised by two researchers; Buxton & Hanney (1994) from Brunel University's Health Economics Research Group (HERG), to measure the impact of health services research using the following five impact categories (in italics), with the specified impact indicators for each, as shown below;

- *Knowledge production; j*ournal articles; conference presentations; books; book chapters; research reports
- *Research targeting and capacity building;* better targeting of future research; development of research skills, personnel and overall research capacity; staff development and educational benefits
- *Informing policy and product development;* improved information bases for political and executive decisions; development of pharmaceutical products and therapeutic techniques

- *Health and health sector benefits*; improved health, cost reduction in delivery of existing services, qualitative improvements in the process of delivery, improved equity in service delivery
- *Broader economic benefits; w*ider economic benefits from commercial exploitation of innovations arising from R&D, economic benefits from a healthy workforce and reduction in working days lost.

Table 2-6 below illustrates how these impact categories have been adopted in other broad disciplinary groups:

Table 2-6: Payback Framework categories as adapted for research evaluation in arts and humanities, and social sciences

	original Payback Framework impact categories – health care research (Buxton & Hanney, 1994)	adapted to social sciences Wooding *et al*. (2007)	adapted to arts and humanities Levitt *et al*. (2010)
Academic Impacts	-knowledge production -research targeting, capacity building and absorption	-knowledge -impacts on future research	-public knowledge creation
Broader Impacts	-informing policy and product development -health and health sector benefits -broader economic benefits	-impacts on policy -impacts on practice -wider social and economic impacts	-impacts on preservation of heritage -impacts on leisure and entertainment -direct economic effects -economic effects on wider society
Methods used	- key informant interviews (principal investigators, researchers) -case studies	-document review -key informant interviews -survey -case studies	-key informant interviews (principal investigators, researchers, research users) -survey -case studies

One major difference that can be noted from the description of broader impacts in Table 2-6, is the use of the term 'impact' in both Wooding's (2007) and Levitt *et al.*'s (2010) studies, as opposed to 'benefits' as originally used by Buxton & Hanney (1994). Wooding *et al.* (2007, p.42) argue that this is because in health care research there is a generally accepted understanding of what counts as an improvement to public health, and there are techniques for measuring these, such as Quality Adjusted Life Years (QALYs). In contrast, in the employment sector and wider society, there is less consensus on how to assess whether a change is a net improvement, for example, some changes may benefit the employee at the expense of the employer, hence moving away from descriptions based on 'benefits' to one based on 'impacts' Wooding *et al*. (2007, p.42).

Another key difference between the three frameworks in *Table 5* is the inclusion of research users as key informants in the evaluation process, as was the case in Levitt *et al*.'s (2010) arts and humanities study. Interviews with external users of research were carried out, the interviewees including senior people from arts journalism and law and architecture professions were done to were called on to clarify their interactions with, and uses of arts and humanities research. Levitt *et al*. (2010) argue that this is instrumental in helping to capture impacts on preservation of heritage and impacts on leisure and entertainment.

2.4.5.3. Optimising the capturing of broader impacts

There have been a number of ways suggested for optimising the capturing of broader impacts; one of them is co-production between the producers and users of research (Armstrong & Alsop, 2010, p.209). Co-production entails involving users throughout the research process; i.e. from agenda-setting, through design, fieldwork and communication of outcomes. This ensures that researchers and policy-makers share a mutual understanding of the relevance of each other's interests and activities, thereby deepening the understandings of the way in which academic research can add value and offer insights to key issues of concern for policy-makers (Armstrong & Alsop, 2010, p.209). Some research funders have begun formulating their funding policies with an emphasis on co-production; one of them is the National Endowment of Arts (NEA) in the US. The NEA is a federal agency responsible for awarding research grants for Arts projects (NEA, 2012, p.1). Through its "Our Town" initiative, in 2011, the NEA began awarding grants with the requirement of involving at least two "partners" from a not-for-profit organisation and a local government entity (NEA, 2012, p.5).

There can be complexities in applying this policy to some disciplines however. Psychology and sociology are two examples in which researchers have personal interactions with subjects; owing to ethical and privacy concerns, there is the question of how much access to research outputs such as data would users or partners have? Would research subjects be comfortable with their personal data being shared with partners such as local government officials for example? Although, there is the argument that data can be anonymised, it has been argued by others (Ceci, 1988, p.47) that for psychologists for example, the practice of sharing data "would not be keeping in spirit of their subject solicitation agreement".

2.4.3.2. Broader impact and public engagement

Co-production stated above, is a type of 'public engagement' activity - *public engagement*, covers diverse academic activities ranging from 'inreach' (Featherstone, Wilkinson & Bultitude, 2009, p.13) such as open days, and outreach such as exhibitions and public lectures, and has become increasingly prominent in academia over the past three decades. The phrase 'public engagement', as noted by the Centre for Higher Education Studies (2009, p.2) evolved from the term 'public understanding of science' which came into prominence in the UK in the 1980s; the idea being that if the public were to be more supportive of science, they had to understand better the issues behind it. One of the drivers of this was *The Bodmer Report*, commissioned by the Royal Society (1985) to raise awareness of the importance of public understanding of science - an issue the report stated was important, not only for the scientific community, but also for the nation and all of its citizens (Royal Society, 1985, p.5). In the late 1990s the need for a two-way communication (as opposed to the one-way communication characterising public understanding of science) between the scientific community and the public grew, with the prospect that this would allow the public a "sense of ownership of science" by engaging with issues raised within the scientific community – this became known as 'public engagement' (Centre for Higher Education Studies, 2009, p.2).

The UK House of Lords Science and Technology Committee (2000) recognised the pivotal role Research Councils, Higher Education (HE) Funding Councils and other funding bodies played in promoting public engagement by academics. Various initiatives began to emerge, most notably the National Co-ordinating

Centre for Public Engagement (NCCPE), established in 2008 as part of the Research Councils, HE Funding Councils and Wellcome Trust-funded Beacons of Public Engagement initiative. This was established to promote and inspire a 'culture of change' in how universities engage with the public, with six 'beacons' (or university-based collaborative centres) established to facilitate this (NCCPE, 2008). In the past few years these funding bodies have sought to promote embedding the vision of a 'culture of change' into research organisations' mission statements. An example is the Concordat for Engaging the Public with Research (RCUK, 2010) which spells out the Research Councils commitment to encouraging and supporting researchers to take part in public engagement.

The emergence of broader impact criterion in research evaluation has meant that in addition to teaching and research, universities, more than ever, are increasingly expected to have a "third mission" (de Jong et al., 2014, p.89), that of prioritising the exploitation of knowledge beyond the academic community and into the society as a whole. Public engagement becomes relevant within this context of the 'third mission' as a mechanism for disseminating research that also allows participation of non-academic audiences, some of whom may potentially go on to 'use' the research, and create impact. There are, therefore, issues to consider such as researchers' motivations in taking part in public engagement activities in an effort to facilitate the impact of their research, and researchers' attitudes towards policies encouraging them to take part in public engagement. Also, which audiences (i.e. schools, local government, charities etc.) are relevant to researchers, and whether any disciplinary differences are apparent?

2.4.6. The challenges of evaluating broader impacts

Evaluating broader impacts of research is faced with challenges; some of these include the *time lag* between research outputs and impact, and *attribution* of impacts to a particular individual or research project.

2.4.6.1. Time lag

The time it takes for research to translate from academia into wider societal benefits is largely unknown; nevertheless, there have been studies suggesting that in the biomedical and health sciences for example, it can be on average seventeen years (Health Economics Research Group, 2008, p.42; Morgan Jones *et al.* 2013, p.5). Research projects or outputs however, can be ignored within academia and the wider community, but may experience a revival in later years and achieve considerable and unexpected impacts at a much later date – this may be due to "fashions and trends" in research (Levitt *et al.* 2010, p.31). In philosophy for example, which seeks to have a deeper understanding of fundamental issues including current global challenges such as economic growth and global warming, there is a possibility of the time lag between the outputs of a certain research project and its broader impacts being shorter than the seventeen years stated above (Levitt *et al.* 2010, p.31). This presents a challenge in selecting the appropriate timing for capturing the duration and persistence of impact. Therefore, if the evaluation is conducted too soon following completion of the research, few impacts (or none) may be apparent. On the other hand if the evaluation is conducted too late, the link between the earlier research may be broken (Bell, Shaw & Boaz, 2011, p.235; Morgan Jones *et al.* 2013, p.5).

There have been attempts however, to address time lags of health research evaluations for example. Frank *et al*. (2009, p.74) gives an example of how this has been done by evaluators through the use of clinical guideline studies that identify the time from publication of research to its inclusion in clinical guidelines, as the minimum time to health impact. Using this method for evaluation is problematic though, since it only applies to impacts that occur through clinical guidelines, but it does not provide an approach for estimating times to impacts (Frank *et al*. 2009, p.74).

For the REF 2014, the eligibility period for research underpinning case studies was set to between 1 January 1993 and 31 December 2013; giving a maximum time lag of 20 years. This applied to all REF Units of Assessment except architecture whose time lag was extended to a maximum of 25 years (i.e. 1 January 1988 to 31 December 2013). This decision has been questioned by some scholars, most notably Penfield *et al*. (2014, p.26) who argue that there is justification for extending to some areas such as medicine and English literature which may also require time lags longer than 20 years for the impacts of the research to be realised.

2.4.6.2. Attribution

Closely related to time lag is the issue of attributing certain impacts to a particular project or individual. In their study on devising an impact framework for health research projects in Canada, Frank *et al*. (2009, p.266) give three examples illustrating the challenges of attributing broader impacts wholly or partially to research findings:

i) attributing impacts to Canadian research findings specifically (as opposed to those from other countries)
ii) attributing impacts to Canadian health research findings (as opposed to those from other fields).
iii) attributing impacts to specific research findings (such as those from a funded study)

Although, academic impact can be traced or attributed to the author(s) through citations, attribution of broader impacts to a certain research project, as shown by the examples above is problematic. This is due to the presence of a complex set of interactions between multiple institutions including firms, public sector research institutes, policy making bodies, universities, users and consumers (PA Consulting & SQW Consulting, 2007, p.35). These complex set of interactions have an influence on both the time lag and attribution of broader impacts. Therefore, when trying to measure the impacts of research on policy for example, there is difficulty in attributing the outcomes to individuals or individual research projects, when so many factors influence the policy-making process (Levitt *et al*. 2010, p.31; Bell, Shaw & Boaz, 2011, p.234).
A research project is likely to have multiple research inputs such as different research grants and collaborators working in different research institutions and result in multiple journal articles, reports etc. (outputs). These multiple linkages get increasingly complex as one progresses downstream to assess broader impacts Morgan Jones *et al*. (2013, p.13). Boaz, Fitzpatrick & Shaw (2009, p.266) use an example of evaluating the impact of research on policy formulation in Fig 2-2 below:

Figure 2-2: Problems in attributing research impact on policy – adapted from Boaz, Fitzpatrick & Shaw (2009, p.266)

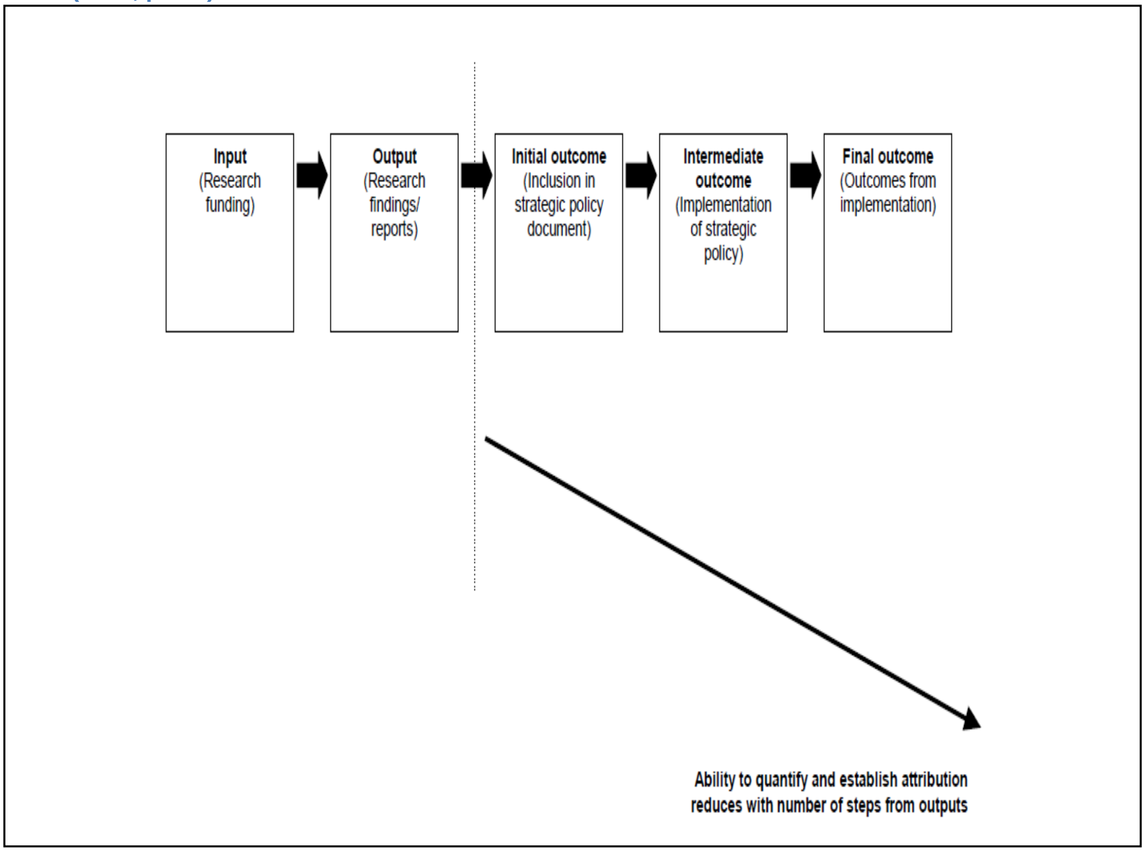


Fig 2-2 illustrates how the ability to attribute and evaluate the impact of a research project on policy reduces with the number of steps from outputs. After research findings are published and initially used by policy-makers to formulate strategy, due to a range of other factors influencing the policy formulation process, it may not be clear on the degree of impact the research findings of the particular project in question have had on the outcomes from implementing the policy. This is partly to do with the notion of 'knowledge creep' (Weiss, 1980, p.381) whereby ideas from research sub-consciously 'creep' into policy deliberations as taken-for-granted assumptions, thereby making it difficult to trace which research project in particular influenced the implementation of a policy.

2.4.7. Relationship between the concepts of open science and research impact

As argued by Whytte & Pryor (2011, p.201), open science has an influence on the the speed and productivity of research, such productivity could be due to scientific advances or collaboration, as a result of reuse of data (RIN, 2008, p.26). In a study carried out by RIN (2008) many interviewees who published or shared their data were often asked to be co-authors of papers for which re-used data was the basis. Collins (2011, pp.26-27) identifies indicators that could be used to evaluate the impact data has within the academic community, in Table 6 below:

Table 2-7: Academic impact indicators from research data (sourced from Collins, 2011, pp.26-27)

Academic impact indicators	Example
Research efficiency	-has open access to data reduced duplication of effort (i.e. unnecessary recreation of data? -has it reduced the financial cost of data acquisition/processing?
Research practice and quality benefit	-has it improved the evidence base of researchers? -has it increased the use of data in a researcher's study?
Research novelty	-has it permitted more novel research questions to be answered/tackled? -has it created created new intellectual opportunities (e.g. merging of several data sets to answer new questions)?
Research training	-has it enabled researchers to improve research training?

With the above indicators in mind, from which disciplines are researchers likely to share their data, what is their motivation, and what impact does the data have on other researchers? Also, would data users publish more journal papers due to increased access to data? There are disciplinary differences to consider here; for example, it was discussed in section 4.3.3.7 that applied economists, for example, spend more time collecting original data and consequently may publish articles less frequently than theoretical economists who rely on secondary data and tend to publish more often (Harley *et al*. 2010, p.321). This presents the following questions: in what way would OS impact how for example, both applied and theoretical economists publish their articles? For example, would easier access to data make applied economists publish more? In addition, there is evidence (Wheeler, 1989; Elton, 2000; Ballon & Westermann, 2006) of researchers breaking down their research findings into the "least publishable unit" in order to increase their total number of publications; would easier access to data actuate this?

The role of OS in influencing broader impacts, on the other hand, is a challenge to evaluate, largely due to the problem of attribution discussed earlier. However, some scholars (Kalucy *et al*. 2009, p.2; Bell, Shaw & Boaz, 2011, p.234) have argued that policy makers for example, depend on evidence from systematic reviews and syntheses of a body of research, rather than non-replicated evidence from single projects. This is because, more often than not, research projects are often part of a wider portfolio of projects which interact with each other, and consequently research outputs and impacts are often cumulative over a series of projects (PA Consulting & SQW Consulting, 2007, p.36). A question arises then, whether open availability of data or workflows, software etc. from a research project would ultimately lead to impact on formulating policy? Fig 2-3 below, attempts to illustrate this:

Figure 2-3: Simplified illustration of the potential impact of open science on policy

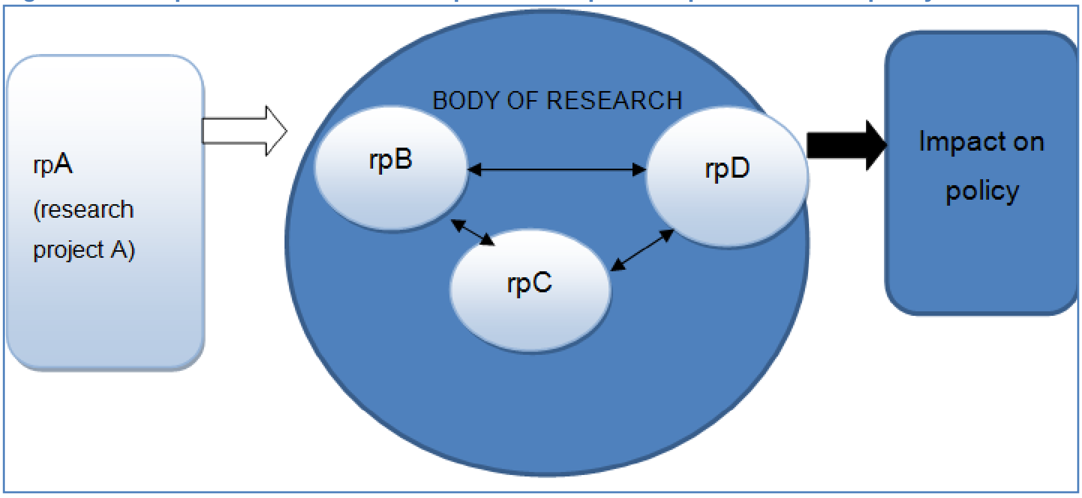


Fig 2-3 shows how a certain research project by researcher A, through the open availability of data, workflows, software etc. has the potential of making an academic impact (as indicated by the white arrow) by allowing other researchers (B,C and D) to for example, improve the evidence base of their research or reduce the unnecessary recreation of data – ultimately enriching the evidence base on which policy-makers can base policies, thereby leading to the development of an existing policy or the formulation of a new policy. There is complication however in tracing or attributing how much influence researcher A has had on formulating the policy in question.

2.4.8. Summary

The notion of evaluating academic impact using citation-based metrics for example brings to light notable disciplinary differences with regards to the cited half-life of publications. Although evaluating the broader impacts of research may be desirable, there are questions that remain, particularly with regards to issues of both time lag and attribution of the socio-economic impacts of a certain research project. Moreover, the proposed frameworks for evaluating broader impacts illustrate a range of impact indicators that could be used to evaluate research impact across different disciplines. As such, it would be interesting to explore what opinions researchers from different disciplines have with regards to indicators that could be used for evaluating the impacts of the research they carry out.

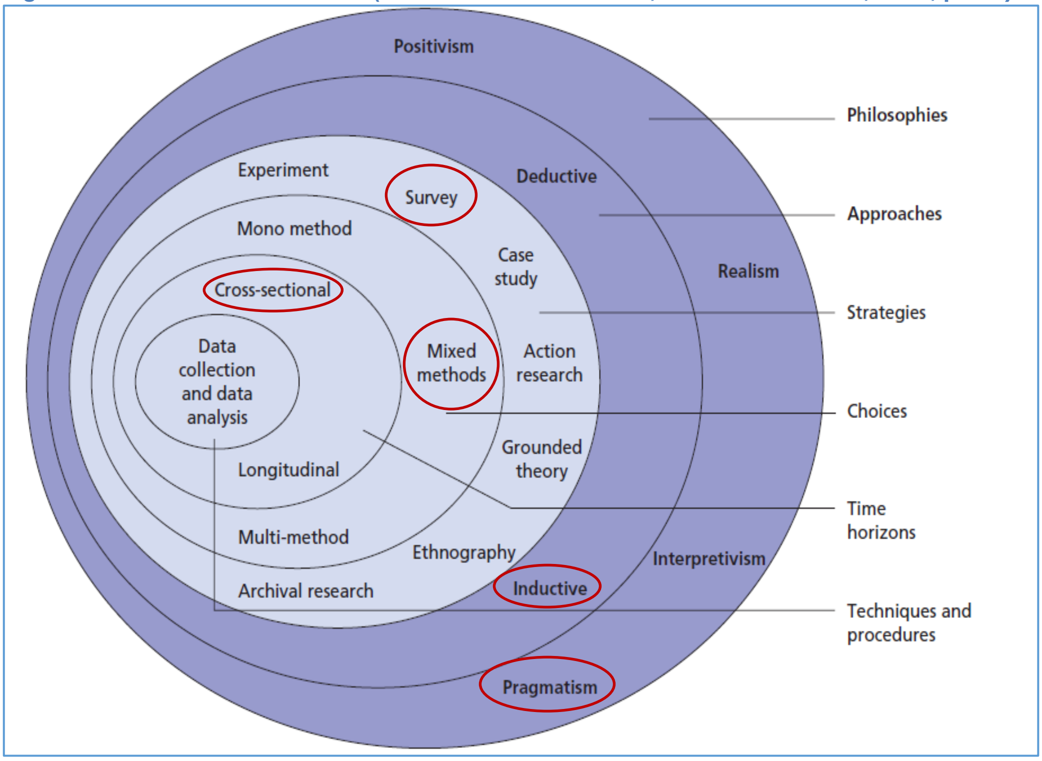
Chapter 3: RESEARCH METHODOLOGY

3.1. Introduction

This chapter details the research methodology adopted for this project. The research 'onion' by Saunders, Lewis & Thornhill (2009) shown in Fig 3-1 below, has been used to structure the chapter under the following headings.

- Research philosophy
- Research approach
- Methodological choice
- Research strategy
- Time horizon

Figure 3-1: The research 'onion' (sourced from Saunders, Lewis & Thornhill, 2009, p.108)



The Saunders, Lewis & Thornhill (2009) research 'onion' serves as a guide for researchers to be aware of the factors that must be considered when formulating the methodology of a research project. As shown in Fig 3-1, each layer presents the available choices at the disposal of the researcher, with the selected choice highlighted in the red borders.

3.2. Research philosophy

Researchers are presented with various philosophies as shown in Fig 3-1 above, which offer world views and a perspective that informs the research design (Saunders, Lewis & Thornhill, 2009, p.108). This research follows a pragmatism philosophy. Pragmatism is described by Creswell (2003, p.10) in the following way:

> *"Pragmatism is not committed to any one system of philosophy and reality. This applies to mixed methods research in that inquirers draw liberally from both quantitative and qualitative assumptions when they engage in their research."*

Cresswell (2003, p.10) adds that, with the pragmatic view, instead of focusing on a particular method (i.e. whether to use quantitative or qualitative method) researchers focus on the research problem, and use all the available approaches to understand it. In other words, as asserted by Holden & Lynch (2004, p.406), a pragmatic approach entails applying methods that suit the research problem, rather than methods that suit ontological (nature of reality) or epistemological (nature of knowledge) concerns.

Pragmatism emerged out of a long-running debate between advocates for quantitative and qualitative research methods (Howe, 1988; Johnson & Onwuegbuzie, 2004; Holden & Lynch, 2004). Johnson & Onwuegbuzie (2004, p.14) note the term "incompatibility thesis" coined by Howe (1988, p.10) to describe the "stalemate" between these advocates (or "incompatibilists") who argue that qualitative and quantitative approaches, including their associated methods cannot, and should not be mixed. This incompatibility thesis stems from two philosophies; positivism and interpretivism (Howe, 1988, p.13). The two philosophies are said to be incompatible, with the positivist philosophy supporting quantitative methods, whilst the interpretivist philosophy supports qualitative methods (Howe, 1988, p.13). These two philosophies are distinguished below by the ontological and epistemological stance adopted by each.

Positivism is characterised by a *realist* ontological stance whereby reality exists independent of those 'creating' the reality; in other words, social facts are seen to exist independent of human interaction, in the same way as natural laws exist (Pickard, 2013, p.8). This can be contrasted with the *relativist* ontological stance typically associated with the interpretivist philosophy which holds that multiple constructed realities cannot exist outside the social contexts that created them. In other words, realities vary in nature and are time and context bound (Pickard, 2013, p.8)

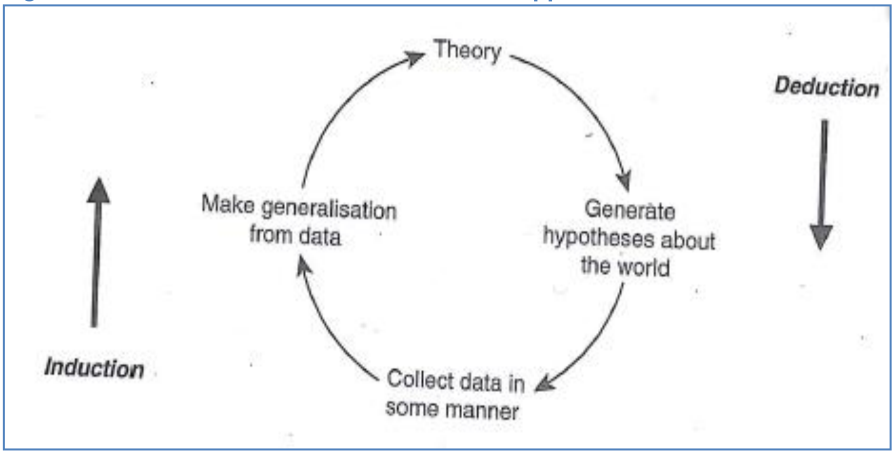
Positivism and interpretivism can also be contrasted by the epistemological stances adopted by each. Positivism adopts an *objectivist* epistemological stance whereby researchers perceive that their studies can be done independently of what is being observed, and that their interests, values, beliefs, etc. will have no influence on what they study or what methods they use (Holden & Lynch, 2004, p.402). Interpretivism on the other hand, adopts a *subjectivist* epistemological stance. Noting the work of Hunt (1993), Holden & Lynch (2004, p.402) assert that subjectivists reject the objectivist view, and argue that researchers cannot distance themselves from: (i) what is being observed, (ii) the study's subject matter, or (iii) the methods of study; in other words, their interests, values and beliefs have an influence on what is being observed, the study’s subject matter and the methods of study. Pragmatists, however, challenge this distinction between objectivity and subjectivity; they argue that epistemological issues exist on a continuum, rather than two opposing poles (Teddlie & Tashakkori, 2009. p.90).

The key difference between positivism and interpretivism in contrast to the pragmatic viewpoint, as noted by Plowright (2011, p.184), is that while pragmatism relies on the *consequences* of a researcher’s beliefs, positivism and interpretivism rely on the *antecedents* of a researcher’s belief. Antecedent beliefs are beliefs that precede our current beliefs and enable us to arrive at justified true beliefs or certain knowledge (Plowright, 2011, p.184). With positivism and interpretivism, these beliefs are used to select the research methods, as opposed to the pragmatic approach whereby beliefs arise as a consequence of the research question, which in turn shapes the research methods to be used. With pragmatism, what is most fundamental is the research question(s), and the chosen methods should follow the research question in a way that offers the best chance to obtain useful answers (Johnson & Onwuegbuzie, 2004; Giacobbi, Poczwardowski & Hager, 2005) - this departs from the traditional view (i.e. positivism and interpretivism) which holds that research methods are determined by philosophical perspectives (Plowright, 2011, p.181). For this project, the researcher developed the research questions (as informed by the literature review) highlighted in section 1.2 and used this to guide him towards selecting the most suitable methods. The quantitative method served to use statistical tests to investigate differences in the research dissemination practices of academics across discipline groups. The qualitative method, on the other hand, sought to investigate the motivations and perceptions behind researchers' accounts on how impacts are planned and achieved.

3.3. Research approach

There are two approaches that can be used by a researcher to describe the role theory plays in both data collection and analysis on a particular research project - the deductive and the inductive approach. The deductive (or rationalist) approach, involves the researcher developing a theory and hypothesis (or hypotheses) and designing a research strategy to test the theory; whereas the inductive (or empiricists) approach involves collecting data and developing a theory as a result of the data analysis (Saunders, Lewis & Thornhill, 2007, p.117). Both approaches are shown in Fig 3-2 below;

Figure 3-2: The inductive-deductive research approaches



Source: Lee & Lings (2008, p.7)

It should be noted however that although these approaches can be individually selected, depending on the nature and purpose of a particular study, they are not mutually exclusive; in other words, as asserted by Saunders, Lewis & Thornhill (2007, p.119) and Teddlie & Tashakorri (2009, pp.87-89) it is possible to combine both deduction and induction at any point within the inductive-deductive research cycle. This project however adopted only the inductive approach, as it did not seek to develop a theory and then test it, as is the case with the deductive approach. Rather, it aimed to collect data (through a questionnaire and interviews) and develop a theory (on academics' research dissemination practices and their attitudes towards the concept of 'research impact') as a result of the data analysis.

3.4. Methodological choice

Three primary methodological choices are available for selection by a researcher; quantitative, qualitative and mixed methods. The quantitative choice is typically chosen by researchers aligned to a positivist philosophy, who are concerned with numerical data and analyses; whereas the qualitative choice is usually chosen by researchers aligned to an interpretivist philosophy, who are principally interested in narrative data and analyses (Teddlie & Tashakorri, 2009, p.4). The term "mixed methods" - used as shorthand for research that integrates both quantitative and qualitative methods within a single project (Bryman, 2012, p.628), is used by researchers interested in both narrative and numeric data in their analyses (Teddlie & Tashakorri, 2009, p.4). It is this latter methodological choice, consisting of a questionnaire (quantitative) and interviews (qualitative), that was selected for this project for the following reasons:

- *Completeness*; combining research methods produces a more complete and comprehensive picture of the topic of the research (Robson, 2011, p.167). For example, by using a questionnaire, the researcher has an opportunity of identifying a range of issues with regards to dissemination of research outputs, and statistically make comparisons across discipline groups. Moreover, with the interview method, the interviewer has the opportunity to uncover attitudes towards research evaluation mechanisms.
- *Offsetting weaknesses of each method;* a mixed methods design can help neutralise the limitations of each method, while building on their strengths

(Robson, 2011, p.167). For example, while questionnaires are cheaper and quicker to administer, they do not give the researcher an opportunity to ask and probe complex questions like interviews do. A more detailed discussion of the strengths and limitations of the two methods is made in 3.5.1 and 3.5.2 below.

Creswell (2009, pp.206-208) recommends that when planning mixed methods procedures, the following factors should be taken into account: timing, weighting, mixing, and theorising. These are explained in the left column in Table 3-1 below, with the right column indicating how they have been applied in this project.

Table 3-1: Mixed methods factors for consideration in research design (adapted from Cresswell, 2009, p.206-208)

Factors to be considered in research design	**Application of these factors in this research**
Timing Refers to the timing of qualitative and quantitative data collection i.e. whether it will be in phases (sequentially) or gathered at the same time (concurrently).	Data collection was done in phases, beginning with the questionnaire then interviews, therefore sequentially.
Weighting Refers to the weight or priority given to quantitative or qualitative research.	The study's three research questions outlined in section 1.2 can be more adequately addressed by qualitative means; with quantitative data playing a complementary role (this is further explained below).
Mixing Refers to mixing the data, the research questions, philosophy and interpretation: *when* does the researcher mix data in a mixed methods study? Also, *how* does mixing occur?	This is particularly challenging, taking into account that quantitative data consists of numbers, whereas, qualitative data consists of text and images (Creswell, 2009, p.207). In this research, quantitative data reflects the broad picture of research dissemination practices between disciplinary groupings whilst qualitative data conveys the meanings of that broad picture, specifically investigating researchers' attitudes and behaviour towards the concept of 'research impact'.
Use of theories Refers to whether a larger, theoretical perspective (for example attribution theory or motivation theory in the social sciences) guides the entire design. Such theories shape the types of questions	Becher's (1987) typology of disciplines is used to categorise participants into four disciplinary groups in order to identify any disciplinary differences with regard to researchers' practices and attitudes towards the concept of 'research impact'

asked, who participates in the study, how data are collected etc.	

As briefly stated in Table 3-1 above, data was collected sequentially, rather than concurrently - starting with the online survey questionnaire, followed by the interviews. This approach allowed for the exploration of questionnaire results in more detail through the interviews; for example, while the questionnaire established which non-academic audiences researchers engaged with their research (public engagement), interviews helped to better understand their experiences in engaging with these audiences, the motivations for taking part in public engagement and the barriers they faced. Collecting data sequentially also aided in recruiting interviewees, as the last question of the survey questionnaire asked participants whether they would be willing to take part in interviews. The sequential mixed methods design is illustrated by Fig 3-3 below:

Figure 3-3: Sequential mixed methods research design for research project

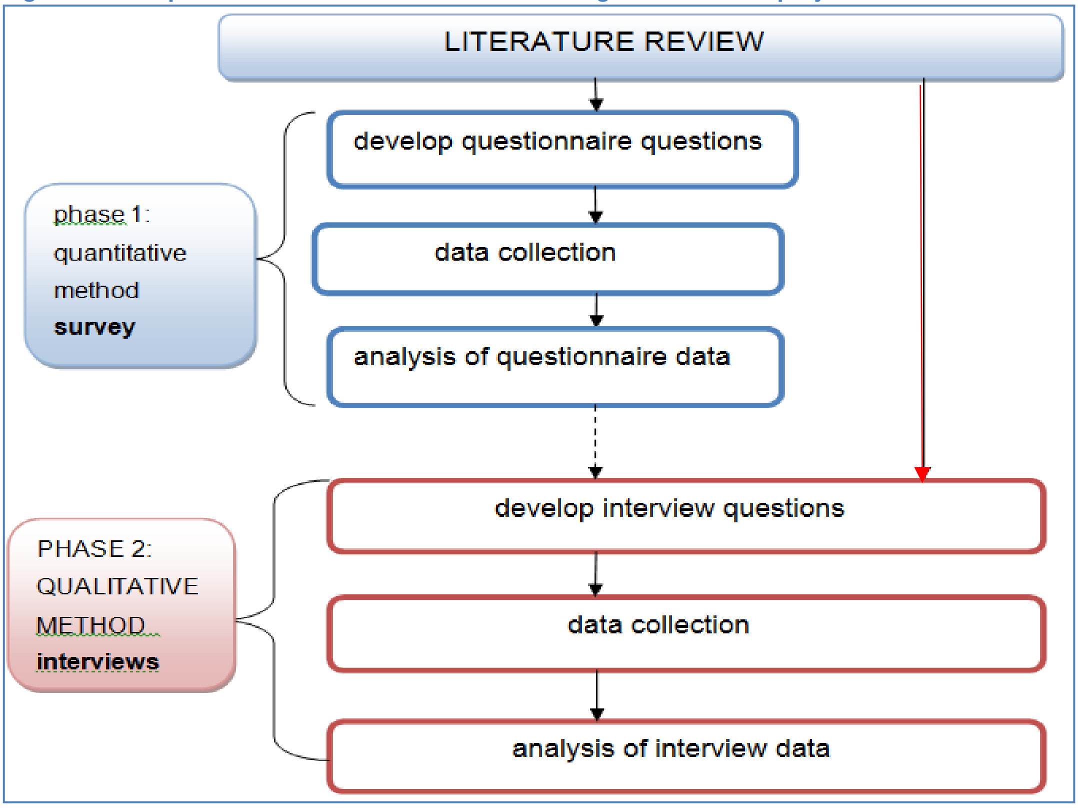


Fig 3-3 shows the two phases of data collection. It illustrates that analyses of questionnaire data guided development of interview questions as shown by the dotted arrow. The red arrow, however, illustrates that there were some questions drawn from the literature review, which could be more suitably addressed by interviews only; for example, investigating perceptions of the term ‘research impact’ and attitudes towards research evaluation mechanisms.

3.5. Research strategy

As shown in the research ‘onion’, researchers have at their disposal various research strategies such as experiments, case study, experiment, survey etc. that they can use for deciding how they collect their data.

3.5.1. Experiments

This research strategy was discounted at the start as it involves “the researcher manipulating systematically, some feature of the environment, and then observing whether a systematic change follows in the behaviour under study.” (Singleton, Straits & Straits, 1988, p.10) – this study is based on self-reporting by participants through a questionnaire and interviews, rather on observation. Moreover, although experiments have been used in the social sciences (by psychologists for example), they are mostly appropriate for use in the natural sciences, involving testing tentative explanations and predictions about the causal relations between variables (Aldridge & Levin, 2001, p.7). A more suitable strategy was considered – the case study.

3.5.2. Case study

The case study strategy involves a detailed investigation of phenomena within their context, with the aim of understanding how behaviour and/or processes are influenced by, or influence that context (Hartley, 2004, p.323). The case study, as noted by Hartley (2004, p.323) is particularly suited to research questions which require detailed understanding of social or organisational processes because of the rich data collected in context.

This strategy would have been appropriate if the aim of the project was to look at selected universities and investigate how research impact is perceived by different stakeholders (including academics and academic leaders) then make comparisons between the universities. Instead, this project looks at perceptions of research impact by individual researchers, and for comparison purposes, explore whether disciplinary group characteristics' affect the discussion. With this in mind, the case study strategy was discounted.

3.5.3. Survey

With the above alternatives considered, it was decided that a *survey* research strategy would be most suitable for the purposes of this study. A survey research strategy is one whereby the same information about all the cases (in this context, researchers) in a sample is collected (Aldridge &Levin, 2001, p.5). The variables gathered from the survey strategy, as suggested by Aldridge & Levin (2001, p.5) can be classified into three broad types;

- attributes – i.e. characteristics such as years of research activity, job title, gender.
- behaviour – i.e. questions such as 'what?' (e.g. *what types of data do researchers make openly available?*) 'how often?' (e.g. *how frequently do researchers carry out research that requires external funding?*)
- opinions, beliefs, preferences, attitudes – questions on these four characteristics serve to probe the respondents point of view, for example - what do you understand by the term "impact" in the context of your area of research?

Questionnaires, face-to-face interviews, telephone interviews, focus groups and observation are some of the methods/tools that can be used to collect data in a survey strategy. The following two sub-sections make a case for questionnaires and face-to-face interviews, which were selected for this project.

3.5.3.1. Survey research strategy - focus groups

The focus group method involves a group of participants taking part in a discussion on a particular topic that is moderated by the researcher. They generally work best for topics concerned with convictions and beliefs of others; and, as asserted by Threlfall (1999, p.102) group interaction allows the researcher the opportunity to "tap into the motivation and subliminal areas of the human psyche”. Moreover, such interaction creates the perspective of multiple realities within the group, while at the same time collaboratively focusing on themes and commonalities on the chosen topic (Threlfall, 1999, p.102). In addition to being comparably less costly than other methods such as one-to-one interviews for example, focus groups put control into the hands of the participants i.e. interaction between participants themselves substitutes interaction between participants and the interviewer, thereby giving more prominence to the points of view of the respondents (Liamputtong, 2011, p.4). This ‘interactionist perspective’ Threlfall (1999, p.102) is often lost when using other methods such as one-to-one interviewing.

With focus groups, however, there is a risk that some participants may find themselves agreeing with the majority because they do not feel as personally responsible for the outcome of the group process as they would if interviewed individually (Liamputtong, 2011, p.4). Moreover, in the context of institutional experiences such as workplaces, people may be reluctant to express their opinions or reveal their personal experiences in front of colleagues, hence not being sufficiently in-depth to allow a researcher to gain a good understanding of the participant’s experience (Liamputtong, 2011, p.4). This is a particularly important point considering the nature of this project, as the goal is to uncover individuals’ perceptions and attitudes towards research impact. Therefore, whereas the focus group method would allow a potentially interesting discussion on this topic, it would be limited in making fleshing out the personal perceptions and attitudes of individuals.

With this in mind, a self-administered online survey *questionnaire* was selected as one of the methods for data collection – the other being *face-to-face interviews*.

3.5.3.2. Survey research strategy - questionnaires

This method was thought suitable as it would give valuable quantitative data on a range of issues including the number and types of research outputs produced across different disciplinary groups, the channels used to disseminate them, the audiences (schools, industry etc.) researchers identify as relevant to their research.

Questionnaires, as noted by Denscombe (2003, p.159) have the advantage of *supplying standardised answers* i.e. all respondents are posed with the same questions without scope for variation that would otherwise take place when using face-to-face methods, such as interviews. Moreover, questionnaires accommodate use of different types of questions such as Likert Scale, rate items, and semantic differential, all of which allow for *speedy collation and data analysis*.

There are limitations with using questionnaires, however, as observed by Bryman (2012, p.271); one of these include the *problem of memory,* whereby participants may misremember information. Other limitations include *poor response rates*, which could be as a result of 'survey fatigue' (Aldridge & Levin, 2001, p.20) whereby respondents are overwhelmed with other surveys being circulated; and the *social desirability effect* whereby participants may exhibit a tendency towards replying to questions based on ideas or behaviours that are widely held in positive regard by society.

3.5.3.3. Survey research strategy – face-to-face interviews

Some of the ways used to distinguish interviewing methods are the *channel* of communication – telephone or face-to-face; and the *degree of structure* of the interview – structured, semi-structured or unstructured. This project will make use of face-to-face, semi-structured interviews. This is because, in terms of the mode of communication, face-to-face interviews allow the interviewer to establish trust and rapport with respondents, something that is not afforded by telephone interviews (Singleton, Straits & Straits, 1993, p.264). Likewise, in terms of the degree of structure of the interview, semi-structured interviews make use of an interview guide to ensure that the same basic lines of enquiry are pursued with each interviewee (Patton, 2002, p.343) at the same time letting the interviewee develop ideas and speak more widely about the issues raised by the interviewer (Denscombe, 2003, p.167). This is particularly suitable considering the nature of this project whereby the researcher intends to let researchers from different disciplinary groups present their ideas on issues such as how they perceive the use of socio-economic impact as criterion for research evaluation, and probe on the efforts they are making in planning and maximising the impacts of their research.

Unstructured interviews, on the on the other hand, were deemed unsuitable as they involve a wide-ranging discussion with individual questions being *developed spontaneously* as the interviewer progresses (Singleton, Straits & Straits, 1993, p.249) – the researcher has set questions he intends to ask, rather than spontaneous ones. The opposite of unstructured interviews, structured interviews involve questions and response categories being set in advance by the interviewer, thereby making interviewees fit their experiences and feelings into the interviewer's categories (Patton, 2002, p.349). This makes them limiting in exploring researchers' views on the issues highlighted in the paragraph above.

3.6. Time horizon

This project adopts a cross-sectional, rather than a longitudinal time horizon. A cross-sectional time horizon is one in which data from a sample or cross-section of respondents chosen to represent a particular target population are gathered at essentially one point in time (Singleton, Straits & Straits, 1993, p.254). The cross-sectional time horizon consists of two variants – contextual and sociometric. A contextual, cross-sectional time horizon includes sampling enough cases within a particular group or context to describe accurately certain characteristics of that context; for example, selecting 30 participants from a sample for interviews – six representing each of five discipline groups. A sociometric, cross sectional time horizon on the other hand, requires interviewing every participant in the sample under investigation (Singleton, Straits & Straits (1993, p.254). Although this approach would allow obtaining rich data, it was rejected for the purposes of feasibility; i.e. limited time and funds. With this in mind, the former - the contextual, cross-sectional time horizon was thought to be more suitable for this project.

The opposite of the cross-sectional time horizon, the longitudinal time horizon seeks to establish the direction of causal relationships between variables over a certain period of time (Singleton, Straits & Straits, 1993, p.255), and mostly used to establish trends in public opinion over, for example, political issues. In the context of this project, a longitudinal time horizon would have been suitable for investigating attitudes towards research evaluation methods, between research evaluation cycles, for example between REF 2014 and REF 2020. However, this is not feasible under the three-year PhD programme the researcher is enrolled on.

3.7. Summary

The above discussion on the methodology underpinning this project is summarised below by the bulleted list introduced earlier in section 3.1., this time, indicating the selections made from the methodological choices (as shown in Fig 3-1) available for consideration by a researcher:

- Research philosophy - *pragmatism*
- Research approach - *induction*
- Methodological choice – *mixed methods*
- Research strategy - *survey*
- Time horizon – *cross-sectional (contextual)*

The chapter has addressed all the layers of the research ‘onion’ apart from the core, which will be addressed in the next two chapters - 4 and 5. Chapters 4 and 5 will present and analyse the results of each data collection method (i.e. questionnaire and interviews) as well as include an account of how these data collection methods were designed and administered.

Chapter 4: SURVEY QUESTIONNAIRE

4.1. Introduction

With the methodology underpinning this project having been discussed in Chapter 3, Chapter 4 is dedicated to presenting the results of the survey questionnaire – detailing how it was designed and administered. The chapter begins by detailing how the questionnaire was designed (section 4.2.), then proceeds to describe how the questionnaire was administered (section 4.3) and finally, the subsequent results and analyses are presented (section 4.4).

4.2. Survey Questionnaire Design

The designing of the survey questionnaire entailed being able to devise a method of accurately identifying respondents' research areas, ensuring that the content of the questionnaire addressed the research objectives, piloting and refining the questionnaire, and finally administering it.

4.2.1. Identifying respondents' research areas

A crucial part in designing the questionnaire was ensuring that it adequately captured respondents' research areas; the following options were explored in order to address this:

4.2.1.1. Asking participants to state the name of their department/school

This approach was discounted because the department/school that one belongs to does not necessarily translate to the research area(s) that one carries out; hence participants were not asked to state the name of their department or school on the questionnaire. Moreover, this method is unworkable in practice especially when seeking participants from more than one university, as universities have different organisational structures. For example, from the fifteen universities considered in this research; some had *divisions* (e.g. Cambridge, Nottingham), whilst some had *departments* and *schools*; some even had *teams* within each school (for example, Nottingham Trent) or *groups* (e.g. Aston, Cambridge).

4.2.1.2. Asking participants to type their research areas

Asking participants to type their research areas would present ambiguity on the part of the respondents in that they have the freedom to be as general or as specific as they chose in describing their area of research. For example, a respondents could state, ‘natural sciences’ to describe the area of their research, whilst another could be more specific; by typing for example, parasitology. This would present problems in the analysis of the results, particularly in cases whereby a respondent has typed an obscure or less well known area of specialisation, thereby causing complications in knowing in which of Becher’s (1987) quadrant to assign the participant.

4.2.1.3. Asking participants to select from the Higher Education Statistics Agency (HESA, n.d.) list of academic disciplines

HESA (n.d.) publishes a list of academic disciplines in higher education. Although this option gives the participants the opportunity to select their specific research areas; with 1552 disciplines, the list is quite extensive, and would have reduced both the aesthetic value and functionality of the questionnaire. Moreover, it would have also presented problems in assigning all the disciplines to the quadrants. A closer look at the HESA (n.d.) website reveals that the 1552 disciplines were categorised into 36 broad disciplines which were used as units of assessments (UoA) for the UK REF. Using the 36 REF UoA allowed for a more manageable list that can be assigned to the Becher (1987) quadrants, and also be incorporated into the questionnaire without compromising its functionality and aesthetic value.

To assign the 36 REF UoA to Becher’s (1987) quadrants, an integrated taxonomy by Del Favero (2005), consisting of 98 disciplines (as shown in Table 4-1 below) was used as a reference tool. Del Favero (2005) combined various studies based on Biglan’s (1973) seminal work on discipline classification to come up with an integrated list of disciplines classified into hard/pure, soft/pure, hard/applied, soft/applied groups as shown in Table 4-1.

Table 4-1: Del Favero’s (2005, p.92) integrated list of 98 disciplines classified in four disciplinary groups

HIGH CONSENSUS

Hard/Pure: **astronomy,** atmospheric science,[3] biology,[1] biochemistry,[3] biophysics,[3] **botany, chemistry, entomology,** environmental biology,[3] **geology, math, microbiology, physiology, physics,** plant pathology,[1] statistics,[3] **zoology**

Hard/Applied: **architecture,**[3] **agronomy,** animal science,[1] **computer science,** construction management,[1] **dairy science,** dental sciences(9 areas),[1] engineering, agricultural engineering,[1] **ceramic engineering,** chemical engineering,[2] electrical engineering,[1] industrial engineering,[1] **mechanical engineering, nuclear engineering,** food and nutrition,[1] food science,[1] forestry,[1] **horticulture,** medicine,[1,2] pharmacology,[2] pharmacy,[2] veterinary science[1]

LOW CONSENSUS

Soft/Pure: **anthropology,** art,[1,4,5] classics,[1] **economics,**[4] **English,** fine arts,[1] geography,[1] **German, history,** history/philosophy of education,[1] modern languages,[1] music,[1,4,6] **philosophy, political science, psychology, Russian, sociology,** speech communications[1]

Soft/Applied: **accounting, agricultural economics,** allied medical professions,[3] business,[2] **communications,** community/regional planning,[1] education, adult/continuing education,[1] agricultural education,[1] **education administration,** education/family resources,[1] educational psychology,[1] elementary education,[1] industrial arts education,[1] **secondary education, special education, finance,** health, P.E./recreation,[1] human development,[3] journalism,[1] law,[1] management,[1] marketing,[1] natural resources,[3] nursing,[2] photography,[3] public administration,[3] social work,[3] textiles/clothing,[1] theater,[3] **vocational/technical**

Boldface entries represent classifications in the original Biglan model

[1] Classified by Creswell, Seagren, and Henry (1979) in their test of Biglan's model, which added 43 disciplinary groups based upon classifications

[2] Per Stoecker (1993)

[3] Per Malaney (1986). Classification was not the primary goal of Malaney's study, so classification procedures were not adequately detailed.

[4] Identified as soft/applied by Malaney (1986)

[5] Classified as hard/pure by Stoecker (1993)

[6] Classified as soft/applied and soft/pure by Stoecker (1993)

NB; "**consensus**" in this context refers to the degree to which academics subscribe to a single body of theory (or paradigm).

These 98 disciplines were then mapped onto the 36 UoA; as a result 31 out of 36 were successfully mapped in each relevant quadrant as shown in italics in Table 4-2 below. As for the remaining 5 (in italics), the researcher used prior knowledge from the literature on disciplinary classification by Biglan (1973), Becher (1987, 1989), Becher & Trowler (2001) to identify the most suitable quadrant for assigning a UoA. For example, most engineering disciplines are likely to fall under the hard/applied group, as shown below, hence the 'civil and construction engineering' UoA being assigned to that quadrant.

Table 4-2: The 36 UoA grouped into the four disciplinary groups

	Hard	Soft
Pure	- Biological Sciences - Chemistry - Earth Systems & Environmental Sciences - Mathematical Sciences - Physics	- Anthropology & Development Studies - Art & Design: History, Practice & Theory - Classics - Economics & Econometrics - English Language & Literature - Geography, Environmental Studies & Archaeology - History - Modern Languages & Linguistics - Music, Drama, Dance & Performing Arts - Philosophy - Politics & International Studies - Psychology, Psychiatry & Neuroscience - Sociology - *Theology & Religious Studies*
Applied	-Aeronautical, Mechanical, Chemical and Manufacturing Engineering - Agriculture, Veterinary & Food Science - Allied Health Professions, Dentistry, Nursing & Pharmacy - Architecture, Built Environment & Planning - Clinical Medicine - *Civil & Construction Engineering* - Computer Science & Informatics - Electrical & Electronic Engineering, Metallurgy & Materials - General Engineering - *Public Health, Health Services & Primary Care*	- *Area Studies* - Business & Management Studies - Communication, Cultural & Media Studies, Library & Information Management - Education - Law - Social Work & Social Policy - *Sports & Exercise Sciences, Leisure & Tourism*

4.2.2. Structure of the questionnaire

Once a method of identifying respondents' research areas *(the 36 REF UoA)* had been devised, and an appropriate analytical framework *(the Becher (1987) typology)* for allocating the respondents into disciplinary groups in order to allow comparisons to be made across those groups had been selected, the next stage involved structuring the questionnaire. Table 4-3 below shows the structure and content of the questionnaire, as derived from the research objectives.

Table 4-3: Structure of questionnaire and research objectives

Research Objectives	Questions
General demographic details of respondents	*Section 1: Information about you* Q1. Job title Q2. Gender Q3. Years of research activity Q4. Name of university Q5. Research area a, b, c, - identify a maximum of three additional categories Q6. Type of research carried out; pure, applied etc. Q7. Types of collaboration i.e. within same department, same university etc. Q8. Importance of different sectors (commerce, environment, culture etc.) Q9. Whether researchers have carried out research that requires external funding Q10. Impact of research within the academic community
- To identify the number and types of output (e.g. journal articles, conference papers, books, book chapters, performances, programme reports etc.) researchers have produced within the REF period 2008-2013. *- To identify the channels researchers have used to disseminate these outputs; for example are they using traditional channels such as journals, or other non-traditional channels such as social media and open access repositories?*	*Section 2. Information about your research outputs* Q11. Types and number of outputs produced, and how many were produced as a result of collaboration Q12. Whether social media tools have been used to raise awareness of research Q13. Types of channels used to disseminate research outputs
-To identify the channels (i.e. personal websites, project websites, journal websites, data repositories, open access repositories etc.) used by researchers to disseminate their data, workflows, software and methods (in other words, research by-products). *- To investigate whether researchers' reuse of openly available data, workflows, software and methods has had the impact of, for example, increasing their evidence base, increasing their productivity, or some other impact on research outcomes.* *-To investigate the impact that sharing of data, workflows, software and methods has on sharers. For example, have they been invited for collaborative work or to present at*	*Section 3. Dissemination of research data* Q14. Whether they have made research data openly available Q15. Types of data that they have made openly available Q16. Barriers to sharing data Q17. Where they have uploaded their research data Q18. Impact on researchers as data creators Q19. Impact on researchers as data users

prestigious conferences, media interviews or public talks?	
-To identify types of public engagement activities (e.g. public presentations/demonstrations, media appearances etc.) researchers have carried out in relation to the dissemination of their research.	*Section 4: Public engagement activities* Q20. Whether they had undertaken any public engagement activities Q21. Ways of engaging with the public Q22. Impact of public engagement activities on their research Q23. Motivating factors for taking part in public engagement activities (Likert scale) Q24. Additional motivators for taking part in public engagement activities Q25. Relevant audiences (schools, industry etc.) to researchers
	Section 5: Thank you Q26. Any additional comments regarding the questions in the survey Q27. Whether or not they would be interested in taking part in an interview.

4.2.3. The pilot study

A crucial part of designing the questionnaire was carrying out a pilot study. This stage of the design process is important as it ensures that both the *content* (i.e. leading, presuming and hypothetical questions) and *structure* (i.e. question lay-out on the pages, answer categories and the question numbering system etc.) of the questionnaire make it a suitable as well as an effective tool for data collection (Oppenheim, 1992, p.49).

Four potential pilot participants were contacted to take part in the pilot study and were assured that their participation would remain anonymous. The criterion for selection was based on each participant representing one of Becher's (1987) quadrants, this would allow for the opportunity of acquiring different perspectives on aspects of the questionnaire. In the end, participants from three of the quadrants were able to take part - these were from the following areas; civil and building engineering (hard/applied), arts (soft/pure), and chemistry (hard/pure). Although scholars such as Gillham (2000, p.42) suggest the researcher being present so as to watch how participants react to the survey questions and deal with any queries that arise, this was not possible owing to participants not having enough time to facilitate this.

One of the responses from the pilot study revealed a flaw in one of the questions which asked respondents to select a category (from a list of the 36 REF units of assessment) that most closely describes their area of research, with a follow up question that prompted them to type in their other area of research if they had one. It was thought that the response given by one of the participants, who stated a specific area of their research, would be problematic, particularly when it came to analysing a large data set of participants who have typed different names describing their areas of research. There was a need to find a more standardised way for respondents to answer the question. Therefore, to resolve this, although the main question was retained, the follow-up question however was changed so as to allow participants to select from a maximum of 3 drop-down lists (listing the 36 REF units of assessment) their 'other' research area(s). This would make it possible to add a fifth dimension to Becher's (1987) quadrants, identifying those whose research could not be completely identified by one quadrant, and thus were considered to be interdisciplinary.

Another point of feedback was from one of the respondents who preferred having the drop-down list of research outputs they had produced set in a particular way. Unfortunately, no changes were able to be made with regard to this feedback as the survey software – *Bristol Online* did not have such a function. This particular drawback of Bristol Online however, is offset by the various advantages which led to it being selected as the software most suitable for the survey; these include, free use through a licence held by the researcher's university, it has a template-based workflow for quick changes after piloting, and also allows respondents to save their responses and complete at a later date.

Finally, it was also important to know how long it took respondents to complete the survey, and the pilot study revealed that it took approximately 15 minutes. All the changes resulting from the pilot led to the design of the final version of the questionnaire shown in Appendix 1.

4.3. Recruitment of participants, and administration of questionnaire

For reasons explained below, the survey was carried out in two rounds; *Round 1* ran from 28th January 2014 to 21st February 2014, and *Round 2,* from 4th March 2014 to 28th March 2014.

Round 1

The sample was initially drawn from five universities (De Montfort University, University of Leicester, Loughborough University, Nottingham Tent University and University of Nottingham), all based in the East Midlands region of England. This selection allowed for a breath of disciplines to be considered for the study; particularly for medical, law or humanities disciplines which are either under-represented or non-existent at the researcher's institution - Loughborough University. Another reason was for convenience. As stated above, the questionnaire was also used as a recruitment tool for potential interview participants, hence interviewing participants within the vicinity of Loughborough University would not only be cost-effective, but it would also allow the researcher more flexibility in dealing with unforeseen circumstances such as cancelled or rescheduled appointments.

Heads of all departments/schools at the five universities were sent emails in November 2013 requesting whether they would be willing to circulate the questionnaire to their colleagues; as an incentive they were invited to request a summary of the analysis of the data if they desired. This exercise was done before the questionnaire was designed as a way of gauging whether this was a viable method for distributing the questionnaire. This method of recruitment was selected mainly for three reasons; firstly, the target audience of the survey were 'research-active' staff, about which on some departmental websites such information was not clear; a Head of department/school on the other hand, would have the mailing lists of the relevant potential participants. Secondly, it was considered that there was a possibility of the survey getting more responses when sent to potential participants through the Head of department/school, as opposed to them receiving unsolicited requests directly from the researcher. Thirdly, this method saved time as opposed to the alternative of collating email addresses of staff from across the five universities. A drawback with this method however, was that some Heads of departments/schools who had initially agreed to circulate the survey did not circulate it when it was ready for circulation.

A total of 34 of the 141 contacted agreed, 6 declined and the rest (97) did not reply. The 34 who agreed was considered an encouraging figure, given that the intention was to re-email the 97 in February 2014 when the survey was ready for circulation; with the hope that although the initial non-response may have been due to a lack of interest by some Heads of departments/schools, others may have initially missed the email or were busy the first time it was sent.

The survey was circulated in February 2014, and attained 154 responses over a four-week period. Preliminary analyses proved this figure insufficient to make statistical tests that were valid; therefore, a decision was made to widen the number of participating institutions.

Round 2

As the plan was to recruit interview participants through the questionnaire, the primary criterion for selecting additional institutions, as with Round 1 was based on their proximity to Loughborough University. The search commenced with a set criterion of universities approximately an hour's travel or 60-mile radius from Loughborough University. This criterion however, was extended to 100-mile radius; after it transpired that some websites of universities within the 60-mile radius from Loughborough either had incomplete or unavailable contact details. In the end the following additional ten universities were selected; *Aston, Birmingham, Birmingham City, Cambridge, Coventry, Leeds, Lincoln, Manchester, Sheffield and Warwick* – all within a 100-mile radius from Loughborough University. The questionnaire was then circulated to heads of schools/departments of these universities in March 2014 and attained 106 responses over a four-week period.

4.3.1. Timeline of survey design and administration

Table 3 below gives a summary of the timeline from the designing to the administration of the questionnaire:

Table 4-4: Timeline of survey design and administration

Date	Task
Nov 2013	Emails sent to 141 heads of departments/schools at the five universities requesting their assistance in circulating the survey to their colleagues; 34 agreed, 6 declined, the rest (97) did not reply.
Dec 2013 – Jan 2014	Designing of questionnaire using Bristol Online software
Jan 2014	Piloting of questionnaire
28 Jan 2014	Launch of questionnaire survey – Round 1 Link initially sent to the 34 who had initially agreed, then to the remaining 97 who had not replied
11-12 Feb 2014	Sent reminders
21-25 Feb 2014	Preliminary analyses – number of responses 154. Decision to widen sample
28 Feb-3 Mar	Search of heads of departments/schools emails on 10 university websites
04 Mar-5 Mar	Sent survey link to 330 heads - Round 2
18 Mar-19 Mar	Sent reminders
28 Mar	Close of survey. Total number of questionnaire responses 260; 154 (Round 1) + 106 (Round 2) = 260

Section 4.4 below details the results and analyses of the survey questionnaire.

4.4. Survey Questionnaire Results & Analyses

4.4.1. Introduction

The results and analyses of the survey are presented under the following five main themes:

- Demographic data of respondents
- General information about respondents' research
- Research outputs produced
- Dissemination of research data
- Public engagement activities

4.4.2. Demographic data of respondents

4.4.2.1. Number of respondents

A total of 260 participants took part in the survey – 154 from round 1 and 106 from round 2. Table 4-5 shows the number of heads of schools/departments from fifteen universities contacted to circulate the survey, and those who confirmed to say that they had circulated the survey.

Table 4-5: No. of heads of schools/departments contacted from each institution

University	No. of Heads contacted	No. of Heads who confirmed they had circulated the survey
Aston University	21	7
Birmingham City University	35	6
Coventry University	22	6
De Montfort University	16	5
Loughborough University	19	13
Nottingham Trent University	26	10
University of Birmingham	35	6
University of Cambridge	71	11
University of Leeds	40	5
University of Leicester	33	13
University of Lincoln	15	7
University of Manchester	25	3
University of Nottingham	47	22
University of Sheffield	44	7
University of Warwick	44	3
Totals	493	111

Table 4-5 shows a proportion of only 23% (111/493) of heads of schools/departments who are known to have circulated the questionnaire i.e. those who replied to confirm that they had circulated the questionnaire. A possible reason for both the low number of responses from the Heads of departments/schools, and the low overall number of 260 respondents from fifteen universities is that they may have been short of time. Table 4-6 below shows the number and percentages of survey responses from each institution.

Table 4-6: Q4. Total number and percentages of survey respondents from each institution

University	No. of respondent	%(n=260)
Loughborough University	58	22.3
University of Nottingham	51	19.6
University of Leicester	26	10.0
University of Cambridge	25	9.6
Nottingham Trent University	17	6.5
University of Sheffield	15	5.8
University of Birmingham	11	4.2
Aston University	10	3.8
Coventry University	9	3.5
University of Leeds	9	3.5
Birmingham City University	8	3.1
De Montfort University	6	2.3
University of Lincoln	6	2.3
University of Warwick	5	1.9
University of Manchester	4	1.5
Total	260	100%

Table 4-6 shows the highest percentage (22.3%) of respondents being from the researcher's institution. Also, the graph shows that the top three institutions were from the first round of circulating the survey (where heads of department/schools had been approached about three months before the launch of the survey) as opposed to the second round – where there had been no preliminary approach.

4.4.2.2. Respondents' years of research activity and job titles

Respondents were asked to state how long they had been research active and their job titles shown below:

Figure 4-1: Q3. Respondents' years of research activity

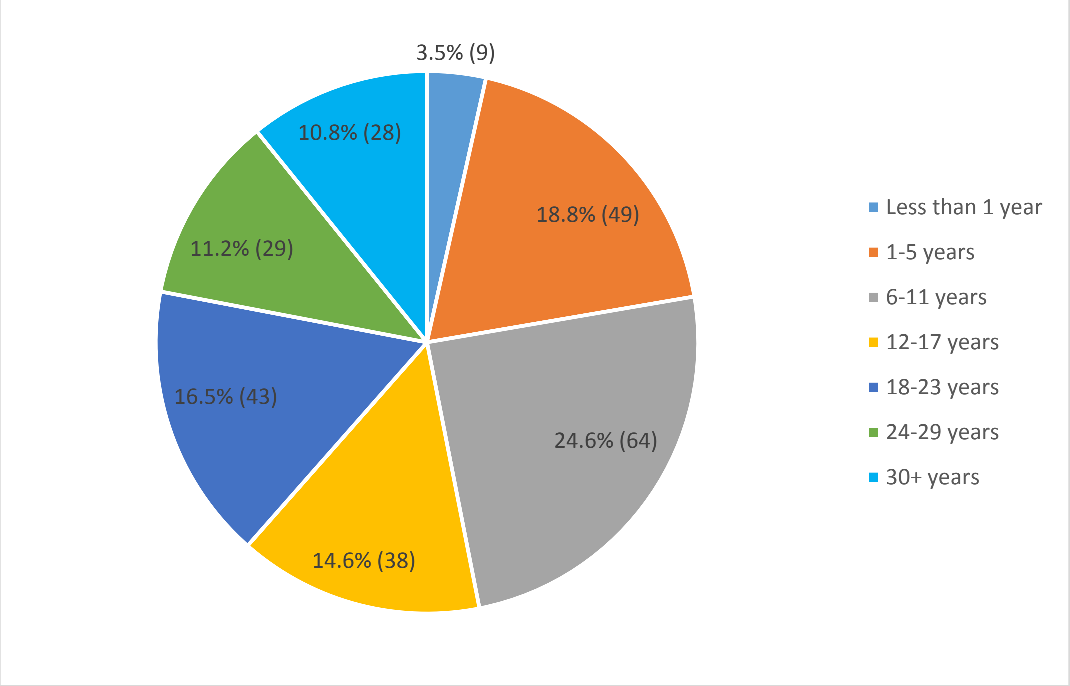


Fig 4-1 shows that about a quarter (24.6%) of respondents had between 6-11 years' research experience, whereas the most experienced researchers (30 years or more) accounted for about a tenth (10.8%) of the total number. The least experienced researchers (less than 1 year) accounted for only 3.5% of the total.

Table 4-7: Q1. Respondents' job titles

Job Title	No. of respondents	% (n=260)
Professor	70	26.9
Lecturer	52	20.0
Senior Lecturer	35	13.5
Other	23	8.8.
Research Fellow	18	6.9
Research Associate	18	6.9
Reader	16	6.2
Associate Professor	9	3.5
Senior Research Fellow	8	3.1
Senior Research Associate	7	2.7
Postdoctoral Research Associate	4	1.5
Postdoctoral Research Assistant	0	0
Total	260	100%

The highest number of responses came from professors (26.9%); the lowest number being from postdoctoral research associates (1.5%), whilst there were no respondents in the 'postdoctoral research assistants' category. For the 'other' category, which accounted for 8.8% of the total; of the 23 respondents were postgraduate research students, accounting for 4% of the total - the survey was open to 'research-active' staff from post-doctoral level and above. The responses to all questions of the postgraduate researchers were checked individually, to see whether it would be beneficial to retain or dispose of them. A decision was made to retain them based on the fact that they had had responses to key questions in the survey such engaging the public with their research and also producing research outputs.

4.4.2.3. Respondents research areas

Respondents were also asked to select their main research area (i.e. the UoA that most closely describes their research), this was a compulsory question. The questionnaire also had three optional questions that allowed respondents to select additional research areas. The results are shown in Table 4-8 below – the thirty-six research areas are arranged according to descending order of the responses participants selected for their main research area.

Table 4-8: Q5. Respondents' main and additional research areas

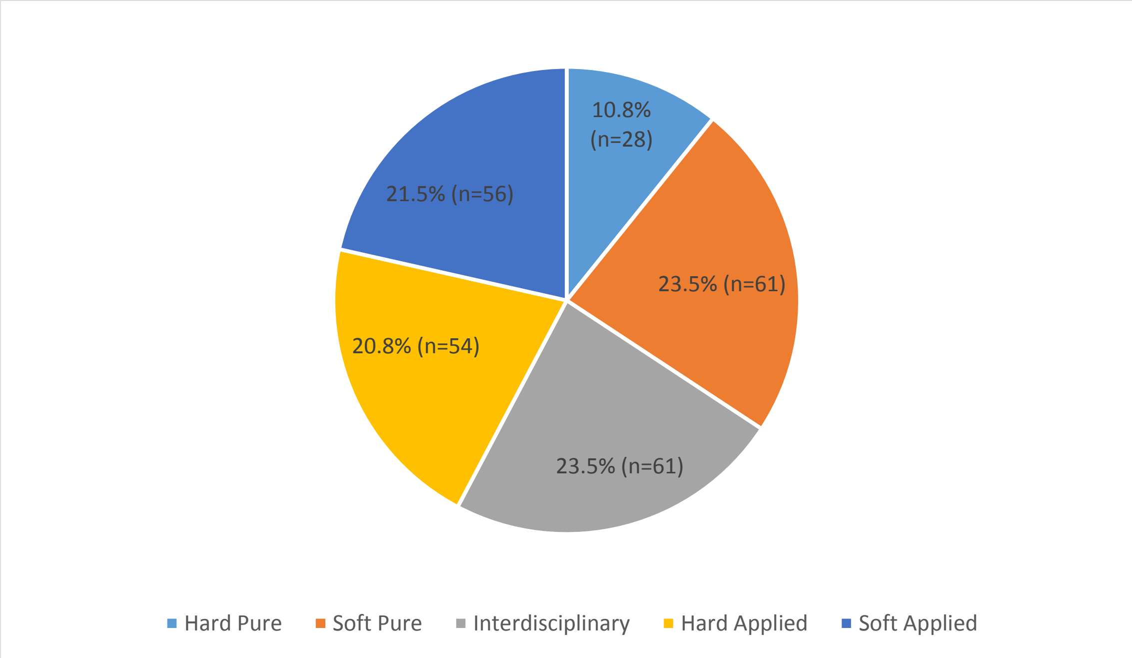
Research areas (UoA) selected by respondents	Main research area		additional research area 1		additional research area 2		additional research area 3	
	No.	% (n=260)	No.	% (n=87)	No.	% (n=42)	No.	% (n=24)
Business & Management Studies	42	16.2	5	5.7	3	7.1	4	16.7
Public Health, Health Services & Primary Care	24	9.2	1	1.1	1	2.4	1	4.2
Biological Sciences	15	5.8	10	11.5	6	14.3	2	8.3
Psychology, Psychiatry & Neuroscience	15	5.8	7	8.0	4	9.5	0	0
Art & Design: History, Practice & Theory	14	5.4	4	4.6	3	7.1	1	4.2
Computer Science & Informatics	11	4.2	4	4.6	0	0	2	8.3
Education	11	4.2	4	4.6	1	2.4	1	4.2
Mathematical Sciences	9	3.5	1	1.1	0	0	1	4.2
Physics	9	3.5	2	2.3	0	0	2	8.3
Aeronautical, Mechanical, Chem. & Manufacturing Eng.	8	3.1	6	6.9	4	9.5	1	4.2
Economics & Econometrics	8	3.1	1	1.1	0	0	0	0
Politics & International Studies	8	3.1	3	3.4	2	4.8	1	4.2
English Language & Literature	7	2.7	1	1.1	0	0	0	0
Geography, Environmental Studies & Archaeology	7	2.7	0	0	1	2.4	1	4.2
Sports & Exercise Sciences, Leisure & Tourism	7	2.7	1	1.1	1	2.4	0	0
Clinical Medicine	6	2.3	1	1.1	0	0	2	8.3
Communication, Cultural & Media Studies, Library & Info. Mgt.	6	2.3	1	1.1	2	4.8	0	0
Electrical & Electronic Engineering, Metallurgy & Materials	6	2.3	1	1.1	2	4.8	0	0

Research areas (UoA) selected by respondents	Main research area		additional research area 1		additional research area 2		additional research area 3	
	No.	% (n=260)	No.	% (n=87)		% (n=42)		% (n=24)
Modern Languages & Linguistics	6	2.3	1	1.1	1	2.4	0	0
Agriculture, Veterinary & Food Science	5	1.9	2	2.3	1	2.4	0	0
Architecture, Built Environment & Planning	5	1.9	2	2.3	0	0	0	0
General Engineering	5	1.9	2	2.3	0	0	1	4.2
History	5	1.9	2	2.3	2	4.8	0	0
Allied Health Professions, Dentistry, Nursing & Pharmacy	4	1.5	2	2.3	1	2.4	1	4.2
Chemistry	4	1.5	2	2.3	0	0	1	4.2
Anthropology & Development Studies	3	1.2	3	3.4	0	0	0	0
Music, Drama, Dance & Performing Arts	3	1.2	0	0	1	2.4	0	0
Sociology	3	1.2	6	6.9	1	2.4	1	4.2
Law	2	0.8	4	4.6	0	0	0	0
Social Work & Social Policy	1	0.4	3	3.4	3	7.1	0	0
Theology & Religious Studies	1	0.4	0	0	0	0	0	0
Area Studies	0	0	2	2.3	0	0	0	0
Civil & Construction Engineering	0	0	1	1.1	0	0	0	0
Classics	0	0	0	0	0	0	0	0
Earth Systems & Environmental Sciences	0	0	1	1.1	2	4.8	1	4.2
Philosophy	0	0	1	1.1	0	0	0	0
Totals	**260**	100%	**87**	100%	**42**	100%	**24**	100%

Table 4-8 shows that 31 out of the 36 UoA were selected as main research areas, with the most represented being Business and Management Studies (16.2%). Although the remaining five main research areas - Area Studies, Civil and Construction Engineering, Earth Systems and Environmental Sciences, and Philosophy were not selected as main research areas, they were selected as additional research areas. None of the respondents however selected Classics as either a main research area or an additional research area.

The respondents were then classed into four disciplinary groups; hard/pure, soft/pure, hard/applied and soft/applied; plus, an additional group – interdisciplinary, to identify those respondents who had selected 1 or more research areas not in the same disciplinary group as the main discipline. For example, if a respondent chose Sociology, then History, they would be categorised as Soft/Pure as both disciplines belong to that group. However, if they selected Sociology then Biological Sciences, they would be classed as Interdisciplinary, as Biological Sciences belongs to the hard/pure group as opposed to Sociology's soft/pure group. The frequencies in each disciplinary group are shown in Fig 4-2 below:

Fig 4-2: Numbers of respondents in each disciplinary group



The preliminary analyses of survey questions using chi-square tests (computed in *SPSS* statistical software) based on the five disciplinary groups however, proved that due to the low response to the questionnaire (n=260) (particularly from the hard/pure disciplinary group, n=28), there were low expected counts (i.e. less than 5) in several of the cells in the majority of the tests. The Pearson chi-square test examines whether there is an association between two categorical variables through testing for their independence. It is calculated by comparing the observed frequencies of cases that occur in each of the categories, with the values that would be expected if there was no association of the variables being measured (Pallant, 2013, p.225).

For chi-square tests to be valid, the expected frequencies in each cell need to be greater than 5, although some authors, as noted by Pallant (2013, p.225) suggest a less stringent criterion: at least 80 per cent of cells should have expected frequencies of 5 or more. This view however is not shared by some; for example, Gillham (2000, p.78) and Field (2009, p.692) who assert that this 80 per cent flexibility may lead to a "loss of statistical power". With this in mind, the general rule applied to the analysis of data from this survey was to apply the chi-square test as advised by Gillham (2000) and Field (2009).

Therefore, to minimise this 'loss of statistical power', rather than assigning respondents' research areas into five (hard/pure, soft/pure, hard/applied soft/applied and interdisciplinary) disciplinary groups, a method that allowed comparing soft with hard disciplines, then pure with applied disciplines was devised. This method still retained the integrity of basing comparisons on the degree that researchers in a discipline subscribe to a single body of theory i.e. paradigm (hard v soft) and the concern of their research in application to practical problems (pure v applied). Table 4-9 below shows how the disciplines from Table 4-2 were regrouped following this new method.

Table 4-9: Hard v Soft disciplines and Pure v Applied disciplines

Hard v Soft	
Hard • Aeronautical, Mechanical, Chemical and Manufacturing Engineering • Agriculture, Veterinary & Food Science • Allied Health Professions, Dentistry, Nursing & Pharmacy • Architecture, Built Environment & Planning • Biological Sciences • Chemistry • Clinical Medicine • Civil & Construction Engineering • Computer Science & Informatics • Earth Systems & Environmental Sciences • Electrical & Electronic Engineering, Metallurgy & Materials • General Engineering • Mathematical Sciences • Physics • Public Health, Health Services & Primary Care	**Soft** • Anthropology & Development Studies • Area Studies • Art & Design: History, Practice & Theory • Business & Management Studies • Communication, Cultural & Media Studies, Library & Information Mgt • Classics • Economics & Econometrics • Education • English Language & Literature • Geography, Environmental Studies & Archaeology • History • Law • Modern Languages & Linguistics • Music, Drama, Dance & Performing Arts • Philosophy • Politics & International Studies • Psychology, Psychiatry & Neuroscience • Sociology • Social Work & Social Policy • Sports & Exercise Sciences, Leisure & Tourism • Theology & Religious Studies
Pure v Applied	
Pure • Anthropology & Development Studies • Art & Design: History, Practice & Theory • Biological Sciences • Chemistry • Classics • Earth Systems & Environmental Sciences • Economics & Econometrics • English Language & Literature • Geography, Environmental Studies & Archaeology • History • Mathematical Sciences • Modern Languages & Linguistics • Music, Drama, Dance & Performing Arts • Philosophy • Physics • Politics & International Studies • Psychology, Psychiatry & Neuroscience • Sociology • Theology & Religious Studies	**Applied** • Aeronautical, Mechanical, Chemical and Manufacturing Engineering • Agriculture, Veterinary & Food Science • Allied Health Professions, Dentistry, Nursing & Pharmacy • Architecture, Built Environment & Planning • Area Studies • Business & Management Studies • Clinical Medicine • Civil & Construction Engineering • Communication, Cultural & Media Studies, Library & Information Mgt • Computer Science & Informatics • Education • Electrical & Electronic Engineering Metallurgy & Materials • General Engineering • Law • Public Health, Health Serv. & Primary Care • Social Work & Social Policy • Sports & Ex. Sci, Leisure & Tourism

The next step was to allocate respondents into the above disciplinary groups i.e. Hard or Soft; Pure or Applied. Table 4-10 below shows an excerpt from SPSS software on how this was done.

Table 4-10: SPSS excerpt of how respondents were allocated into disciplinary groups

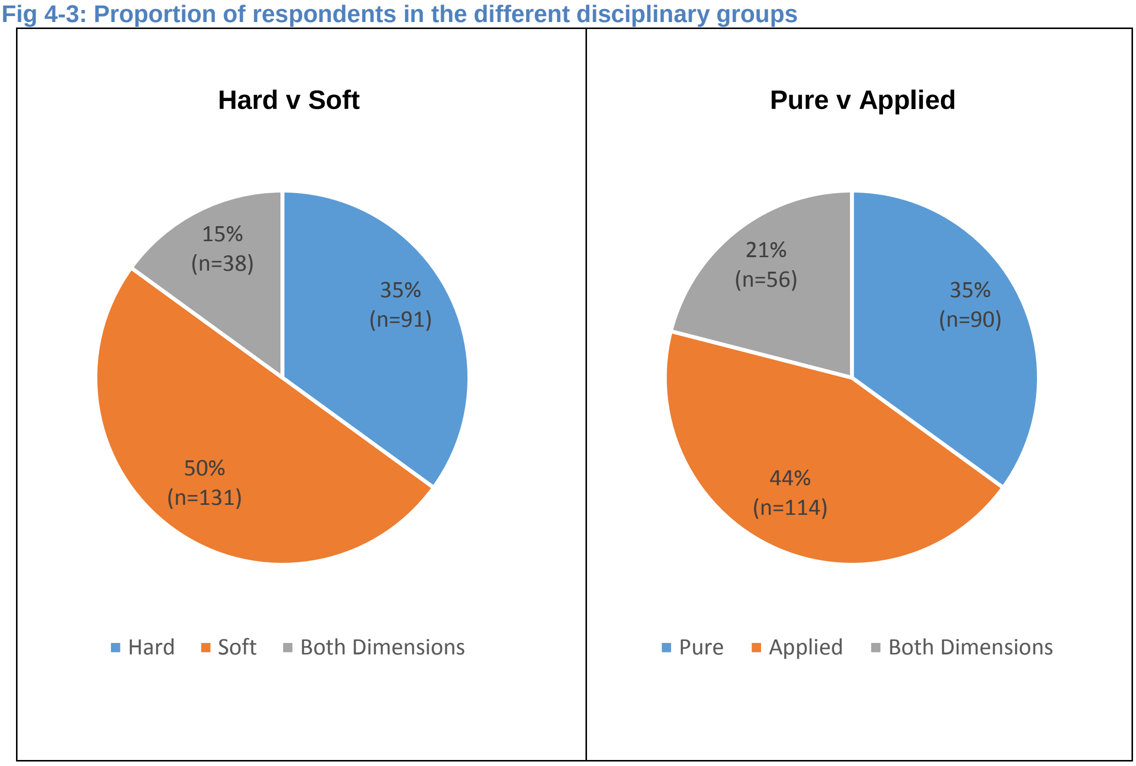
	Q1_JobTit	Q5_Discip	Q5aCat1	Q5bCat2	Q5cCat3	HardVSoft	PureVAppli...
1	Professor	Business and Ma...	Sociology	.	.	Soft	Both dime...
2	Professor	Business and Ma...	.	.	.	Soft	Applied
3	Professor	Business and Ma...	.	.	.	Soft	Applied
4	Professor	Art and Design: ...	.	.	.	Soft	Pure
5	Senior Lecturer	Art and Design: ...	Philosophy	.	.	Soft	Pure
6	Senior Lecturer	Business and Ma...	.	.	.	Soft	Applied
7	Senior Lecturer	Theology and Rel...	.	.	.	Soft	Pure
8	Reader	Physics	.	.	.	Hard	Pure
9	Professor	General Engineer...	Aeronautical, Me...	Public Health, He...	Computer Scienc...	Hard	Applied
10	Other	Sport and Exerci...	.	.	.	Soft	Applied
11	Senior Lecturer	Allied Health Prof...	Psychology, Psy...	Biological Scienc...	.	Both dimensions	Both dime...
12	Research Associ...	Psychology, Psy...	Art and Design: ...	Aeronautical, Me...	.	Both dimensions	Both dime...

For respondent 1 for example, who selected Business and Management Studies (a soft/applied discipline), and an additional selection of Sociology (a soft/pure discipline), when it came to allocating them in the Hard or Soft discipline group, the respondent fell under the Soft discipline group. When it came to allocating them into either the Pure or Applied discipline groups however, because respondent 1's research straddled both the pure and the applied dimensions, the phrase 'Both dimensions' was used to identify their research area. Furthermore, for respondent 7, who selected only Theology and Religious Studies; a soft/pure discipline, when it came to allocating them into either the Hard or Soft discipline group, the respondent fell under the Soft discipline group. Also, when it came to allocating them into either the Pure or Applied discipline group, the fell under the Pure discipline group.

The same principles of allocation were used throughout. For example, respondent 11, who chose 3 research areas; Allied Health Professions (hard/applied), Psychology (soft/pure), Biological sciences (hard/pure); when it came to allocating them into either the Hard or Soft discipline group, they fell under the Both Dimensions classification as their research straddled both hard and soft categories; the same was the case when classifying under either the Pure or Applied discipline group where respondent 11's research straddled both hard and applied categories.

The above changes resulted in the following proportions in the disciplinary groups;

Fig 4-3: Proportion of respondents in the different disciplinary groups



The proportions of respondents' disciplinary groups in Fig 4-3 above, made it possible to do valid tests in a number of questions comparing disciplinary differences in this chapter

4.4.2.4. Presentation of disciplinary differences

This sub-section explains how disciplinary differences will be presented in this chapter. For reasons explained in section 4.4.2.3 above, the unit of analyses adopted for the survey results is a comparison of Hard with Soft disciplines and Pure with Applied disciplines. In both instances, those respondents who were categorised as 'Both Dimensions are included in the analysis as a separate group. Chi-square test results are used to analyse binary data (i.e. yes/no) whilst Analysis of Variance (ANOVA) tests are used to analyse scale data e.g.

‘extremely important, very important, slightly important, not important. Results are reported at the 0.05 significance level; for chi-square tests, a significant association exists between two variables where $p<0.05$; whereas $p>0.05$ means there is no significant association.

ANOVA tests consider main effects and interaction effects - main effect refers to the effect of an independent variable on a dependent variable over the levels of the other independent variable - in this study, the independent variables used in the analyses are the Hard v Soft and Pure v Applied disciplinary groups. An interaction effect on the other hand, is present when the impact of one of the independent variables depends on the level of the other independent variable. Both main effects and interaction effects are reported at the 0.05 significance level, whereby $p>0.05$ represent no evidence of a significant main effect or interaction effect and $p<0.05$ represent evidence of significant main effect or interaction effect.

For each question comparing disciplinary group differences, results are presented in a tabular format, the first table showing responses of Hard and Soft disciplines, the second showing responses of Pure and Applied disciplines.

4.4.3. General information about respondents’ research

This section reports on the introductory segment of the questionnaire which sought to acquire general information about respondents’ research.

4.4.3.1. Type of research (i.e. basic, strategic basic, applied, experimental development) researchers typically engage in.

Respondents were asked to select how frequently they engaged in the following research types

- *Pure basic research*: experimental and theoretical work undertaken to acquire new knowledge without looking for long term benefits other than the advancement of knowledge.

- *Strategic basic research:* experimental and theoretical work undertaken to acquire new knowledge directed into specified broad areas in the expectation of practical discoveries.
- *Applied research:* original work undertaken primarily to acquire new knowledge with a specific application in view.
- *Experimental development:* systematic work, using existing knowledge gained from research or practical experience, which is directed to producing e.g. new materials, products, behaviours, devices; or to improving substantially those already produced or installed.

The above terms are drawn from an Australian and New Zealand Standard Research Classification (ANZSRC) policy document (Australian Bureau of Statistics, 2008). There is not much literature on how these research types have been applied empirically. There is however, the *Frascati Manual* (OECD, 2002) a handbook published by the Organisation of Economic Co-operation Development on standard practice on research and development statistics which includes all the above types except for strategic basic research. It was decided to select the ANZSRC classification over the Frascati Manual as the former acknowledges the existence of two variants of basic research; one that is done solely to acquire new knowledge (pure basic) and one that is done to acquire new knowledge, that can be directed into specified broad areas in the expectation of practical discoveries (strategic basic).

From the four types of research emerged fifteen different types of research types typically engaged by researchers, shown in Table 4-12 below;

Table 4-12: Types of research typically engaged in by respondents

Type of research	No.	% (n=260)
Applied	52	20.0%
Pure basic	51	19.6%
Applied-Experimental development	30	11.5%
Pure basic-Strategic basic	23	8.8%
Strategic basic-Applied	22	8.5%
Strategic basic	19	7.3%
Strategic basic-Applied-Experimental development	18	6.9%
Pure basic-Strategic basic-Applied-Experimental development	14	5.4%
Pure basic-Strategic basic-Applied	8	3.1%
Pure basic-Applied	8	3.1%
Experimental development	6	2.3%
Pure basic-Applied-Experimental development	4	1.5%
Strategic basic-Experimental development	3	1.2%
Pure basic-Experimental development	1	0.4%
Pure basic-Strategic basic-Experimental development	1	0.4%

The Visual Basic programme was used to calculate the research type of each respondent using arbitrary scores between 0 and 8; the highest score (8), denoting researchers who 'Almost always' carried out a type of research (i.e. Pure basic, Experimental development etc.) whilst 0 denotes those who answered 'I don't know'. The other scores between 0 and 8 were 'frequently' (6), 'occasionally' (4) and never (2). Table 4-13 below gives an example of how Visual Basic made the calculations:

Table 4-13: Visual Basic calculation of research types

	Pure basic research	Strategic basic research	Applied research	Experimental development	Resultant classification
Respondent 1	Almost always (8)	Never (2)	Frequently (6)	Frequently (6)	Pure basic
Respondent 2	Never (2)	Occasionally (4)	Occasionally (4)	Occasionally (4)	Strategic basic-Applied-Experimental

Respondent 1 is classed as Pure basic, as they 'almost always' (the highest score selected) undertake Pure basic research. Respondent 2 however, 'occasionally' undertakes Strategic basic, Applied and Experimental development research, as the three are the highest scores selected by the respondent and also carry the same weight, Respondent 2 is therefore classed as Strategic basic-Applied-Experimental.

What the results in Table 4-12 show that although the highest percentages were from those researchers whose research was solely Applied (20.0%) or Pure basic (19.6%), the majority of researchers had practised research classified under a combination of research types; for example, 5.4% practise all four of the research types. Although this question had value in showing the diverse types of research practised by researchers, it could not be used further as an analytical tool for grouping participants and comparing their responses to survey questions. This is because many of the groups (as shown in Table 4-12) would have too few respondents for valid analysis. This limitation justifies using Becher's (1987) typology which allows for respondents to be grouped to a more manageable (five) disciplinary groups as opposed to the fifteen groups shown in Table 4-12.

4.4.3.2. Influence of research in the academic community

Respondents were asked the following question: "*This question relates to the influence of research within the academic community. Thinking about your research over the past five years, please select whether any of the following has taken place as a result of your research"*. The results are presented in Fig 4-5 as follows;

Fig 4-5: Q10. Influence of research within the academic community

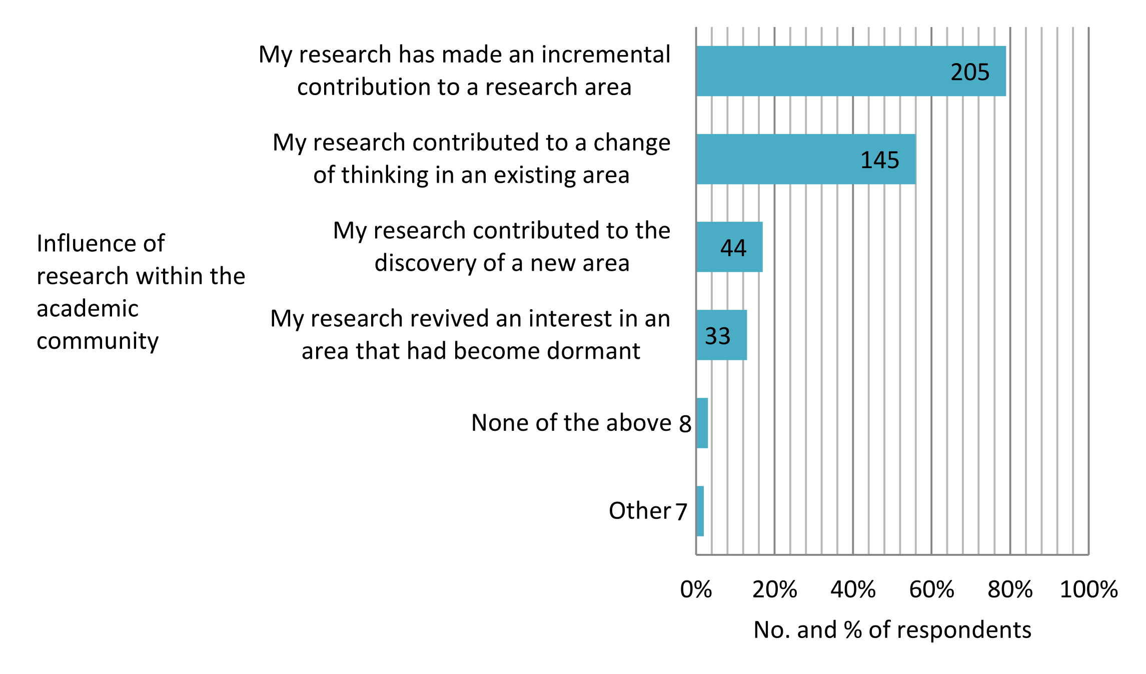


Fig 4-4 shows that the most common impact of research within the academic community reported by respondents was ‘making an incremental contribution to a research area (205=79%), whilst the smallest group (33=13%) stated their research having revived interest in an area that had become dormant.

4.4.3.3. Use of social media tools to raise awareness of research

Respondents were asked whether they used social media tools to raise awareness of their research, the responses are as follows;

Figure 4-6: Q12. Use of social media tools to raise awareness of research (n=260)

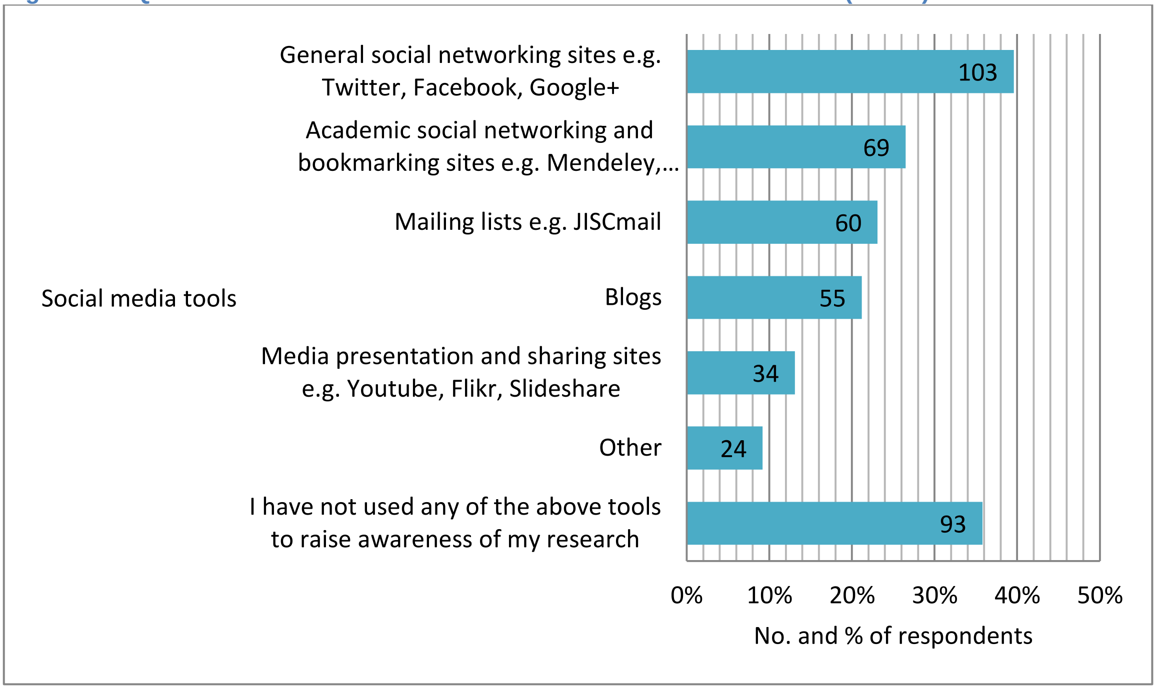


Fig 4-6 shows that some researchers were making use of social networking sites to raise awareness of their research, be it through using general social networking sites such as Twitter and Facebook (39.6%) to those sites mainly used within the academic community such as Mendeley, Bibsonomy, Delicious etc. (26.5%). The interviews helped in investigating from researchers their attitudes towards use of social media as a tool for raising awareness of their research, as discussed in section 5.8.

Disciplinary group differences were apparent for only two of the social media tools, shown above - general social networking sites and mailing lists. Sub-sections 4.4.3.3.1 and 4.4.3.3.2 show that there were disciplinary differences in use of general social networking sites and mailing lists when comparing Hard with Soft disciplines, and none when comparing Pure with Applied disciplines.

4.4.3.3.1. Disciplinary group differences in use of general social networking sites

Chi-square tests showed that there was an association between the disciplinary group to which respondents belong and whether or not they used general social networking sites (Chi-square=12.04, df=2, $p<0.05$), when comparing Hard with Soft disciplines. There was a greater proportion of respondents from Hard (74.7%) than Soft (52.7%) and Both Dimensions (52.6%) disciplinary groups who had not used general social networking sites to raise awareness of their research (Table 4-14).

Table 4-14: Q12. Hard v Soft - Use of general social networking sites

HARD V SOFT			
	Used general social networking sites e.g. Twitter, Facebook?		
	NO	YES	Total
Hard	68 (74.7%)	23 (25.3%)	91 (100%)
Soft	69 (52.7%)	62 (47.3%)	131 (100%)
Both Dimensions	20 (52.6%)	18 (47.4%)	38 (100%)
Total	157 (60.4%)	103 (39.6%)	260 (100%)

There was however no statistically significant association (Chi-square=0.25, df=2, p>0.05) between use of general social networking sites and whether respondents were from Pure or Applied disciplines as illustrated in Table 4-15 below.

Table 4-15: Q12 Pure v Applied - Use of general social networking sites

PURE V APPLIED			
	Used general social networking sites e.g. Twitter, Facebook?		
	NO	YES	Total
Pure	56 (62.2%)	34 (37.8%)	90 (100%)
Applied	67 (58.8%)	47 (41.2%)	114 (100%)
Both Dimensions	34 (60.7%)	22 (39.3%)	56 (100%)
Total	157 (60.4%)	103 (39.6%)	260 (100%)

4.4.3.3.2. Disciplinary group differences in use of mailing lists

Chi-square tests showed that there was an association between the disciplinary group to which respondents belong and whether or not they used mailing lists (Chi-square=11.27, df, p<0.05). There was a greater proportion of respondents from Hard (87.9%) than Soft (68.7%) and Both Dimensions (78.9%) who had not used mailing lists to raise awareness of their research (Table 4-16).

Table 4-16: Q12. Hard v Soft - Use of mailing lists

HARD V SOFT			
	Used mailing lists e.g. JISCmail?		
	NO	YES	Total
Hard	80 (87.9%)	11 (12.1%)	91 (100%)
Soft	90 (68.7%)	41 (31.3%)	131 (100%)
Both Dimensions	30 (78.9%)	8 (21.1%)	38 (100%)
Total	200 (76.9%)	60 (23.1%)	260 (100%)

There was however no statistically significant association (Chi-square=5.19, df=2, p>0.05) between use of mailing lists and whether respondents were from Pure or Applied disciplines as illustrated in Table 4-17 below.

Table 4-17: Q12. Pure v Applied - Use of mailing lists

PURE v APPLIED			
	Used mailing lists e.g. JISCmail?		
	NO	YES	Total
Pure	63 (70.0%)	27 (30.0%)	90 (100%)
Applied	95 (83.3%)	19 (16.7%)	114 (100%)
Both Dimensions	42 (75.0%)	14 (25.0%)	56 (100%)
Total	200 (76.9%)	60 (23.1%)	260 (100%)

4.4.3.4. Influence of research on different sectors

Respondents were asked the following question: *Thinking about your research area(s), please rate how important is the influence of your research on the following sectors - Society, Culture & Creativity, Commerce, Economy, Practitioners and Professional Services, Environment, Health & Welfare, Public Policy & Law and International Development.* The results, along with ANOVA tests are as follows;

4.4.3.4.1. Disciplinary group differences in the importance of Society, Culture and Creativity sector

As shown in Table 4-18 below, a third of the respondents (33%) from the Hard discipline group viewed their research as ‘not important’ in influencing the SCC sector, whereas this lowered to approximately a fifth of respondents in both the Soft (19.8%) the Both dimensions (21.1%) groups. In the same vein, the results show that the highest proportion of respondents who viewed their research as ‘extremely important’ were from the Soft discipline group (22.1%); however, there were no noticeable differences in the proportions across the three discipline groups in both the ‘very important’ and ‘slightly important’ options.

Table 4-18: Q8. Hard v Soft - Influence of research on Society, Culture & Creativity

HARD v SOFT					
	Extremely Important	Very Important	Slightly Important	Not Important	Total
Hard	7 (7.7%)	21 (23.1%)	33 (36.3%)	30 (33.0%)	91 (100%)
Soft	29 (22.1%)	35 (26.7%)	41 (41.3%)	26 (19.8%)	131 (100%)
Both Dimensions	4 (10.5%)	11 (28.9%)	15 (39.5%)	8 (21.1%)	38 (100%)
Total	40 (15.4%)	67 (25.8%)	89 (34.2%)	64 (24.6%)	260 (100%)

Table 4-19 below shows the comparisons between Pure, Applied and Both Dimensions disciplines.

Table 4-19: Q8. Pure v Applied - Influence of research on Society, Culture & Creativity

PURE v APPLIED					
	Extremely Important	Very Important	Slightly Important	Not Important	Total
Pure	20 (22.2%)	23 (25.6%)	28 (31.1%)	19 (21.1%)	90 (100%)
Applied	14 (12.3%)	32 (28.1%)	35 (30.7%)	33 (28.9%)	114 (100%)
Both Dimensions	6 (10.7%)	12 (21.4%)	26 (46.4%)	12 (21.4%)	56 (100%)
Total	40 (15.4%)	67 (25.8%)	89 (34.2%)	64 (24.6%)	260 (100%)

There was a notable contrast between respondents in the Pure disciplinary group compared to those in the Both Dimensions disciplinary group. A greater proportion of respondents in Pure disciplines (22.2%) selected 'extremely important' compared to those in Both Dimensions disciplines (10.7%). In the same vein, a smaller proportion of respondents in the Pure disciplinary group (31.1%) selected 'slightly important' compared to respondents in the Both Dimensions disciplinary group (46.4%).

A two-way analysis of variance (ANOVA) yielded a main effect for the Hard v Soft disciplinary group $F(2,252) = 5.24$, $p<0.05$, such that there was more importance placed on the SSC sector by respondents in the Soft disciplines (M=2.49, SD=1.05) compared to Hard (M=2.95, SD=0.94) and Both Dimensions (M=2.71, M=0.93) disciplines. The main effect of the Pure v Applied disciplinary group was non-significant $F(2, 252) = 1.39$, $p>0.05$.

There was a significant interaction effect $F(3, 252) = 3.08$, $p<0.05$, indicating that the effect of Hard v Soft disciplines on the SSC sector was significantly different within the Pure v Applied disciplinary group. While the means within the Hard disciplinary group were almost similar – Hard/Pure (M=2.97, SD=0.98) and Hard/Applied (M=2.91, 0.95); the means for the Soft disciplinary group showed more importance placed on the SSC sector by respondents within the Soft/Pure (M=2.30, SD=1.04) compared to Soft/Applied (2.73, SD=1.05) disciplinary groups.

4.4.3.4.2. Disciplinary group differences in the importance of the Commerce sector

Table 4-20 shows the importance of respondents' research in influencing the Commerce sector. The smallest proportion of respondents who selected 'not important' were from the Both Dimensions disciplinary group (26.3%). Likewise, it is the Both Dimensions disciplinary group (10.5) which had the greatest proportion of respondents who selected 'extremely important (10.5%) compared to the Hard and Soft disciplines.

Table 4-20: Q8. Hard v Soft - Influence of research on Commerce

	HARD V SOFT				Total
	Extremely important	Very important	Slightly important	Not important	
Hard	3 (3.3%)	14 (15.4%)	33 (36.3%)	41 (45.1%)	91 (100%)
Soft	9 (6.9%)	13 (9.9%)	37 (28.2%)	72 (55.0%)	131 (100%)
Both dimensions	4 (10.5%)	8 (21.1%)	16 (42.1%)	10 (26.3%)	38 (100%)
Total	16 (6.2%)	35 (13.5%)	86 (33.1%)	123 (47.3%)	260 (100%)

With regard to the Pure v Applied comparison, Table 4-21 shows that none of the respondents from the Pure disciplinary group (0%) viewed their research as 'extremely important' in influencing the commerce sector, compared to respondents in Applied disciplines (10.5%).

Table 4-21: Q8. Pure v Applied - Influence of research on Commerce

	HARD V SOFT				Total
	Extremely important	Very important	Slightly important	Not important	
Pure	0 (0%)	6 (6.7%)	29 (32.2%)	55 (61.1%)	90 (100%)
Applied	12 (10.5%)	19 (16.7%)	35 (30.7%)	48 (42.1%)	114 (100%)
Both dimensions	4 (7.1%)	10 (17.9%)	22 (39.3%	20 (35.7%)	56 (100%)
Total	16 (6.2%)	35 (13.5%)	86 (33.1%)	123(47.3%)	260(100%)

An ANOVA test showed a non-significant main effect of the Hard v Soft disciplinary group $F(2,252) = 2.12$, $p>0.05$ on the importance placed by respondents in influencing the Commerce sector. There was however a significant main effect for the Pure v Applied disciplinary group *F*(2, 252) = 6.54, p<0.05; there was more importance placed on the Commerce sector by respondents in the Applied (M=3.04, SD=1.01) and Both Dimensions (M=3.04, SD=0.91) disciplines compared to Pure disciplines (M=3.54, SD=0.62). There was a non-significant interaction effect *F*(3, 252) = 1.61, p>0.05 between the Hard v Soft and Pure v Applied disciplinary groups.

4.4.3.4.3. Disciplinary group differences in the importance of the Practitioners & Professionals Services sector

Table 4-22 shows that of the three groups, the Both Dimensions group had the greatest proportion (34.2%) of respondents who viewed the PPS sector as ‘extremely important’. The results also show that the PPS sector was regarded as ‘not important’ to a greater proportion of respondents in the Hard disciplinary group (25.3) than the Soft disciplinary group (13.0%)

Table 4-22: Hard v Soft - Influence of research on Practitioners & Professional Services

HARD v SOFT					
	Extremely Important	Very Important	Slightly Important	Not Important	Total
Hard	14 (15.4%	29 (31.9%)	25 (27.5%)	23 (25.3%)	91 (100%)
Soft	25 (19.1%)	39 (29.8%)	50 (38.2%)	17 (13.0%)	131 (100%)
Both Dimensions	13 (34.2%)	13 (34.2%)	10 (26.3%)	2 (5.3%)	38 (100%)
Total	52 (20.0%)	81 (32.2%)	85 (32.7%)	42 (16.2%)	260 (100%)

When comparing Pure v Applied disciplines, in Table 4-23 below, 65.8% of respondents from the Applied group viewed their research as either ‘extremely important’ or ‘very important’ in influencing the PPS sector. This is more than double the proportion of respondents from the Pure discipline group (30.0%) and slightly higher than the 55.4% figure from the Both dimensions discipline group. The reverse is true for the Pure disciplinary group whereby 70% of respondents of respondents viewed their research as either ‘slightly important’ or ‘not important’ in influencing the PPS sector compared to 34.2% and 44.6% in the Applied and Both Dimensions groups respectively.

Table 4-23: Q8. Pure v Applied - Influence of research on Practitioners & Professional Services

PURE v APPLIED					
	Extremely Important	Very Important	Slightly Important	Not Important	Total
Pure	7 (7.8%)	20 (22.2%)	38 (42.2%)	25 (27.8%)	90 (100%)
Applied	35 (30.7%)	40 (35.1%)	29 (25.4%)	10 (8.8%)	114 (100%)
Both Dimensions	10 (17.9%)	21 (37.5%)	18 (32.1%)	7 (12.5%)	56 (100%)
Total	52 (20.0%)	81 (31.2%)	85 (32.7%)	42 (16.2%)	260 (100%)

An ANOVA test showed a significant main effect for the Hard v Soft disciplinary group $F(2,252) = 6.07$, $p<0.05$, such that there was more importance placed on the PPS sector by respondents in the Both Dimensions disciplines (M=2.03, SD=0.92) compared to Soft (M=2.45, SD=0.95) and Hard (M=2.63, SD=1.03) disciplines. There was also a significant main effect for the Pure v Applied disciplinary group: $F(2, 252) = 18.73$, $p<0.05$. Whereby more importance was placed on the PPS sector by respondents in Applied disciplines (M=2.12, SD=0.95) than in Pure (M=2.90, SD=0.90) and Both Dimensions (M=2.39, SD=0.93) disciplines. There was, however, a non-significant interaction effect between the Hard v Soft and Pure v Applied disciplinary dimensions: $F(3, 252) = 0.87$, $p>0.05$.

4.4.3.4.4. Disciplinary group differences in the importance of the Environment sector

Table 4-24 shows that over a quarter of respondents in both the Hard (27.5%) and the Both Dimensions (26.3%) viewed their research as either 'extremely important' or 'very important' in influencing the Environment sector, whereas it was just over a tenth (12.2%) in the Soft disciplinary group.

Table 4-24: Q8. Hard v Soft - Influence of research on the Environment

	HARD v SOFT				Total
	Extremely important	Very important	Slightly important	Not important	
Hard	10 (11.0%)	15 (16.5%)	26 (28.6%)	40 (44.0%)	91(100%)
Soft	7 (5.3%)	9 (6.9%)	31 (23.7%)	84 (64.1%)	131(100%)
Both dimensions	3 (7.9%)	7 (18.4%)	11 (28.9%)	17 (44.7%)	38 (100%)
	20 (7.7%)	31 (11.9%)	68 (26.2%)	141 (54.2%)	260 (100%)

There were no notable differences between the Pure, Both Dimensions and Applied disciplinary groups as shown in Table 4-25 below.

Table 4-25: Q8. Pure v Applied - Influence of research on the Environment

	PURE v APPLIED				Total
	Extremely important	Very important	Slightly important	Not important	
Pure	7 (7.8%)	12 (13.3%)	21 (23.3%)	50 (55.6%)	90 (100%)
Applied	9 (7.9%)	11 (9.6%)	30 (26.3%)	64 (56.1%)	114 (100%)
Both dimensions	4 (7.1%)	8 (14.3%)	17 (30.4%)	27 (48.2%)	56 (100%)
Total	20 (7.7%)	31 (11.9%)	68 (26.2%)	141 (54.2%)	260 (100%)

An ANOVA test showed a main effect for the Hard v Soft disciplinary group $F(2, 252) = 5.71$, $p<0.05$, such that there was more importance placed on the Environment sector by respondents in the Both Dimensions disciplines (M=2.71, SD=1.11) compared to Hard (M=3.10, SD=1.05) and Soft (M=3.34, SD=0.93) disciplines. There was a non-significant main effect for the Pure v Applied disciplinary group: $F(2, 252) = 0.24$, $p>0.05$, as well as a non-significant interaction effect between the Hard v Soft and Pure v Applied disciplinary dimensions: $F(3, 252) = 1.47$, $p>0.05$.

4.4.3.4.5. Disciplinary group differences in the importance of the Health & Welfare sector

Table 4-26 below shows that less than 10% of respondents from the Soft disciplinary group viewed their research as 'extremely important' in influencing the health and welfare sector, compared to almost 30% in both the Hard and Both Dimensions groups. The same trend is shown again at the opposite end of the scale whereby 44.3% of respondents from the Soft disciplinary group, compared with 19.8% and 13.2% in the Hard and Both Dimensions groups respectively viewed their research as 'not important' in influencing the health and welfare sector.

Table 4-26: Q8. Hard v Soft - Influence of research on Health & Welfare

	HARD v SOFT				
	Extremely Important	Very Important	Slightly Important	Not Important	Total
Hard	27 (29.7%)	25 (27.5%)	21 (23.1%)	18 (19.8%)	91 (100%)
Soft	13 (9.9%)	25 (19.1%)	35 (26.7%)	58 (44.3%)	131 (100%)
Both Dimensions	11 (28.9%)	11 (28.9%)	11 (28.9%)	5 (13.2%)	38 (100%)
Total	51 (19.6%)	61 (23.5%)	67 (25.8%)	81 (31.2%)	260 (100%)

Table 4-27 below shows that a larger of proportion of respondents from the Pure disciplinary group (43.3%) viewed their research as 'not important' in influencing the health and welfare sector, compared with 26.3% and 21.4% from the Applied and Both Dimensions groups respectively. Moreover, only 10% of respondents in the Pure disciplinary group viewed their research as ‘extremely important’ in influencing the Health and Welfare sector compared to 25.4% and 23.2% from the Applied and Both Dimensions disciplinary groups respectively.

Table 4-27: Q8. Pure v Applied - Influence of research on Health & Welfare

PURE v APPLIED					
	Extremely Important	Very Important	Slightly Important	Not Important	Total
Pure	9 (10.0%)	20 (22.2%)	22 (24.4%)	39 (43.3%)	90 (100%)
Applied	29 (25.4%)	26 (22.8%)	29 (25.4%)	30 (26.3%)	114 (100%)
Both Dimensions	13 (23.2%)	15 (26.8%)	16 (28.6%)	12 (21.4%)	56 (100%)
Total	51 (19.6%)	61 (23.5%)	67 (25.8%)	81 (31.2%)	260 (100%)

An ANOVA test showed a significant main effect for the Hard v Soft disciplinary group $F(2, 252) = 7.42$, $p<0.05$, such that there was more importance placed on the Health & Welfare sector by respondents in the Both Dimensions (M=2.26, SD=1.03) and Hard (M=2.33, SD=1.11) disciplines compared to Soft disciplines (M=3.05, SD=1.02). There was also a significant main effect for the Pure v Applied disciplinary group: $F(2, 252) = 3.09$, $p<0.05$. Whereby more importance was placed on the Health & Welfare sector by respondents in Both Dimensions (M=2.48, SD=1.08) and Applied (M=2.53, SD=1.14) disciplines compared to Pure (M=3.01, SD=1.03) disciplines. There was, however, a non-significant interaction effect between the Hard v Soft and Pure v Applied disciplinary dimensions: $F(3, 252) = 2.16$, $p>0.05$.

4.4.3.4.5. Disciplinary group differences in the importance of the International Development sector

The smallest proportion of respondents who viewed their research as ‘not important’ was from the Both Dimensions (39.5%), compared to Hard (59.3%) and Soft (64.1%) disciplinary groups. There were no notable contrasts between the disciplinary groups on the extremely/very/slightly important options.

Table 4-28: Q8. Hard v Soft - Influence of research on International Development

	HARD v SOFT				Total
	Extremely important	Very important	Slightly important	Not important	
Hard	3 (3.3%)	8 (8.8%)	26 (28.6%)	54 (59.3%)	91 (100%)
Soft	3 (2.3%)	12 (9.2)	32 (24.4%)	84 (64.1%)	131 (100%)
Both dimensions	4 (10.5%)	6 (15.8%)	13 (34.2%)	15 (39.5%)	38 (100%)
Total	10 (3.8%)	26 (10.0%)	71 (27.3%)	153 (58.8%)	260 (100%)

As shown in Table 4-29, overall, not more than 22% of respondents in each group viewed their research as either 'extremely important' or 'very important' in influencing the International Development sector. There are notable differences however, between the Pure group and Both Dimensions whereby about a fifth (21.4%) of respondents in the Both Dimensions, compared to only 5.6% in the Pure group viewed their research as either 'extremely important' or 'very important' in influencing the International Development sector.

Table 4-29: Q8. Pure v Applied – Influence of research on International Development

	PURE v APPLIED				Total
	Extremely important	Very important	Slightly important	Not important	
Pure	1 (1.1%)	4 (4.4%)	25 (27.8%)	60 (66.7%)	90 (100%)
Applied	4 (3.5%)	15 (13.2%)	31 (27.2%)	64 (56.1%)	114 (100%)
Both dimensions	5 (8.9%)	7 (12.5%)	15 (28.8%)	29 (51.8%)	56 (100%)
Total	10 (3.8%0	26 (10.0%)	71 (27.3%)	153 (58.8%)	260 (100%)

An ANOVA test showed a main effect for the Hard v Soft disciplinary group $F(2,252) = 3.17$, $p<0.05$, such that there was more importance placed on the Environment sector by respondents in the Both Dimensions disciplines (M=3.03, SD=1.00) compared to Hard (M=3.44, SD=0.79) and Soft (M=3.50, SD=0.76) disciplines. There was a non-significant main effect for the Pure v Applied disciplinary group: $F(2, 252) = 2.33$, $p>0.05$, as well as a non-significant interaction effect between the Hard v Soft and Pure v Applied disciplinary dimensions: $F(3, 252) = 0.80$, $p>0.05$.

4.4.3.4.6. Summary on influence of research on different sectors

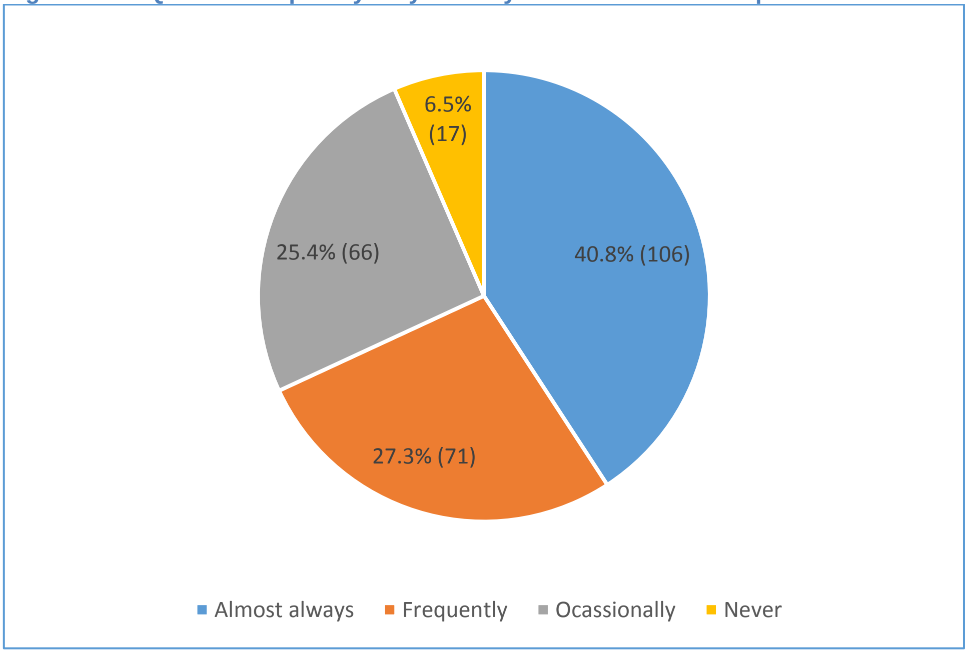
The ANOVA tests showed that there was an interaction effect between the Hard v Soft and Pure v Applied dimensions only on one sector – *Society, Culture & Creativity (SSC)*, whereby there was more importance placed on the SSC sector by respondents from the soft/pure disciplinary group. For the rest of the results only main effects were apparent – the tests showed main effects on the different sectors for either the Hard v Soft (*Environment, International Development)* or Pure v Applied disciplinary group (*Commerce*), or both (*Practitioners & Professional Services, Health Welfare*).

4.4.3.6. Research funding

Respondents were asked how frequently they carried out externally funded research. The purpose of this question was to investigate whether there were any disciplinary group differences in the frequency of carrying out research that required external funding.

When asked how frequently they carried out research that required external funding, respondents answered as follows;

Figure 4-15: Q9. How frequently do you carry out research that requires external funding?



The Fig 4-15 shows that just over two-thirds (68.1%) of respondents either ‘almost always’ or ‘frequently’ carried out research that required external funding.

This can be contrasted with just less than a third (31.9%) who stated that they either 'occasionally' or 'never' carried out research that required external funding. Tables 4-30 and 4-31 below show the responses given by the respondents across the disciplinary groups:

Table 4-30: Q9. Hard v Soft - Disciplinary group responses to 'How often do you undertake research that requires external funding?'

	HARD v SOFT				Total
	Almost always	Frequently	Occasionally	Never	
Hard	57 (62.6%)	20 (22.0%)	7 (7.7%	7 (7.7%)	91 (100%)
Soft	26 (19.8%)	42 (32.1%)	53 (40.5%)	10 (7.6%)	131 (100%)
Both dimensions	23 (60.5%)	9 (23.7%)	6 (15.8%0	0 (0%)	38 (100%)
Total	106 (40.8%)	71 (27.3%)	66 (25.4%)	17 (6.5%)	260 (100%)

The Soft disciplinary group had the least proportion (51.9%) of respondents who either 'almost always' or 'frequently' carry out research that requires external funding, compared to over 84% of respondents in both the Hard and the Both Dimensions groups.

There were no notable differences in the responses given by respondents from the Pure, Applied and Both Dimensions as shown in Table 4-31 below.

Table 4-31: Q9. Pure v Applied - 'How often do you undertake research that requires external funding?'

	PURE v APPLIED				Total
	Almost always	Frequently	Occasionally	Never	
Pure	32 (35.6%)	25 (27.8%0	23 (25.6%)	10 (11.1%)	90 (100%)
Applied	48 (42.1%)	33 (28.9%)	29 (25.4%)	4 (3.5%)	114 (100%)
Both dimensions	26 (46.4%0	13 (23.2%)	14 (25.0%)	3 (5.4%)	56 (100%)
Total	106 (40.8%)	71 (27.3%)	66 (25.4%)	17 (6.5%)	260 (100%)

An ANOVA test showed a main effect for the Hard v Soft disciplinary group $F(2,252) = 16.78$, $p<0.05$, such that respondents from Both Dimensions (M=1.55, SD=0.76) and Hard (M=1.60, SD=0.93) disciplines reported undertaking research that required external funding more frequently than respondents in Soft (M=2.36, SD=0.89) disciplines. There was a non-significant main effect for the Pure v Applied disciplinary group: $F(2, 252) = 0.02$, $p>0.05$, as well as a non-significant interaction effect between the Hard v Soft and Pure v Applied disciplinary dimensions: $F(3, 252) = 2.23$, $p>0.05$.

4.4.3.6. Collaboration

Respondents were asked how frequently they collaborated with the following groups shown in Figs 4-16 to 4-20 below. The pie charts show that the type of collaboration with the largest proportion of researchers who selected 'almost always' was with '*researchers within your research group*' (38.6%) (Fig 4-17); whilst the largest proportion of researchers who selected 'never' was collaboration with '*researchers within your university, but outside your department/faculty'* (23.4%) (Fig 4-19).

Figure 4-17: Q7a. Collaboration with researchers within your research group

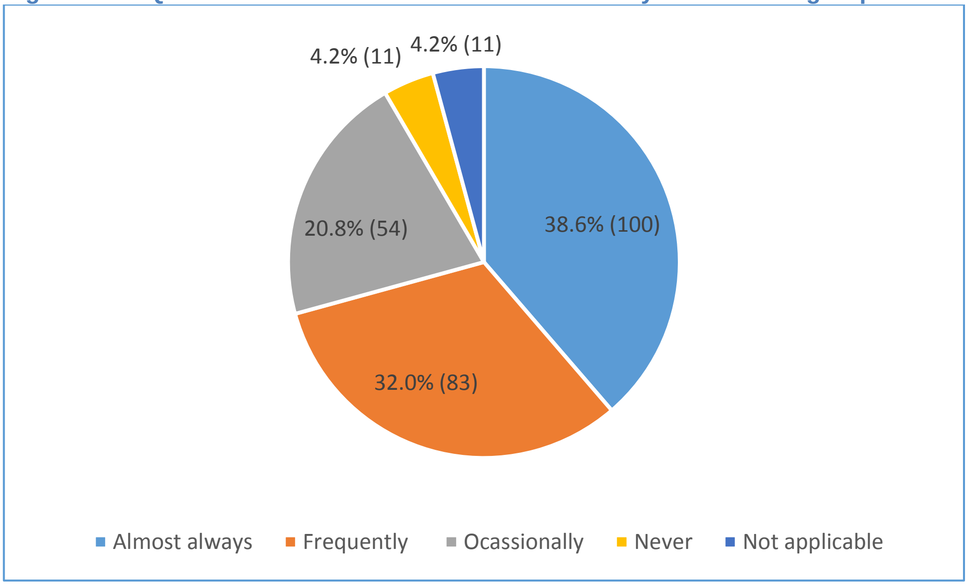


Figure 4-18: Q7b. Collaboration with researchers within your department/faculty, but outside your research group

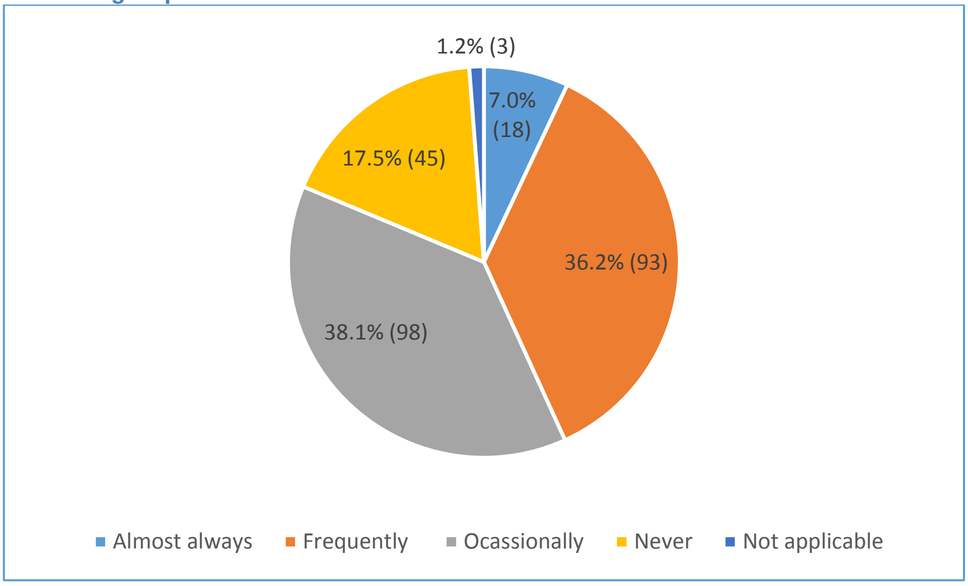


Figure 4-19: Q7c. Researchers within your university but outside your department faculty

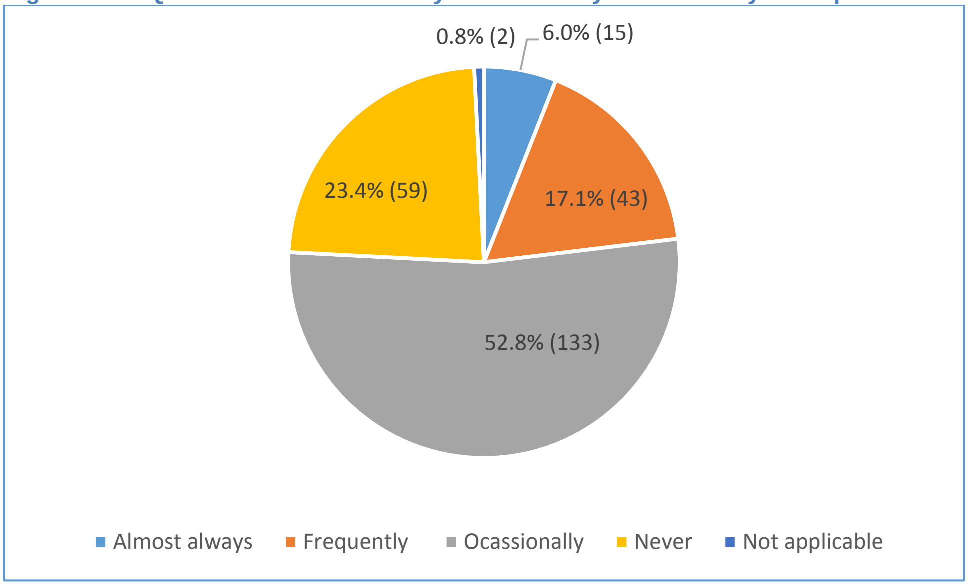


Figure 4-20. Q7d. Researchers from other universities within the UK

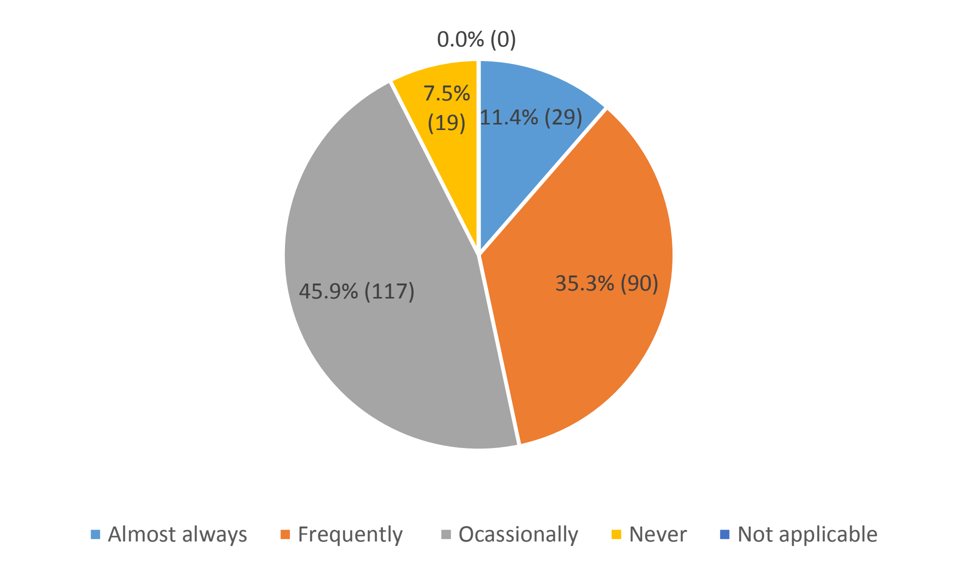
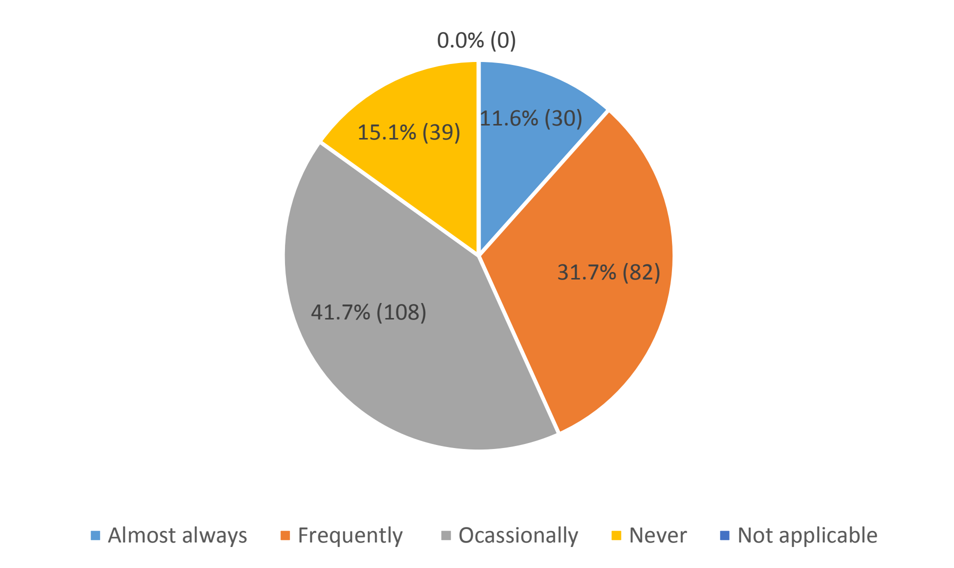


Figure 4-21. Q7e. Researchers from other universities outside the UK



ANOVA tests were undertaken to investigate disciplinary group differences in the types of collaboration above, and all the tests apart from 'collaboration with researchers within your research group' showed non-significant main and interaction effects. 4.4.3.6.1 below shows the responses to 'How frequently do you collaborate with researchers within your own research group?' and the results of the ANOVA tests.

4.4.3.6.1. Disciplinary group responses to 'How frequently do you collaborate with researchers within your own research group?

Table 4-32 shows that the least collaborators with researchers within their research group were from the Soft disciplinary group (62%), whilst a higher proportion of those in the Hard (87.6%) and Both Dimensions disciplinary groups (78.9%) either 'almost always' or 'frequently' collaborated with researchers within their research group.

Table 4-32. Q7. Hard v Soft – Collaboration with researchers within their research group?

	HARD v SOFT					Total
	Almost Always	Frequently	Occasionally	Never	Not Applicable	
Hard	51 (56.0%)	27 (29.7%)	9 (9.9%)	2 (2.2%)	2 (2.2%)	91 (100%)
Soft	33 (25.4%)	42 (32.3%)	37 (28.5%)	9 (6.9%)	9 (6.9%)	130 (100%)
Both dimensions	16 (42.1%)	14 (36.8%)	8 (21.1%)	0 (0%)	0 (0%)	38 (100%)
Total	100 (38.6%)	83 (32.0%)	54 (20.8%)	11 (4.2%)	11 (4.2%)	259 (100%)

There were no notable contrasts between the Pure, Applied and Both Dimensions disciplinary groups in researchers' responses to how frequently they collaborated with researchers within their research group as shown in Table 4-33).

Table 4-33: Q7. Pure v Applied - Collaboration with researchers within their research group?

	PURE v APPLIED					Total
	Almost Always	Frequently	Occasionally	Never	Not applicable	
Pure	32 (35.6%)	28 (31.1%)	17 (18.9%)	6 (6.7%)	7 (7.8%)	90 (100%)
Applied	47 (41.6%)	36 (31.9%)	24 (21.2%)	4 (3.5%)	2 (1.8%)	113 (100%)
Both dimensions	21 (37.5%)	19 (33.9%)	13 (23.2%)	1 (1.8%)	2 (3.6%)	56 (100%)
Total	100 (38.6%)	83 (32.0%)	54 (20.8%)	11 (4.2%)	11 (4.2%)	259

An ANOVA test showed a main effect for the Hard v Soft disciplinary group $F(2,251) = 12.29$, $p<0.05$, such that respondents from Hard disciplines (M=1.65, SD=0.91) collaborated more frequently with researchers within their research group than respondents in Both Dimensions (M=1.79, SD=0.78) and Soft (M=2.38, SD=1.14) disciplines. There was a non-significant main effect for the Pure v Applied disciplinary group: $F(2, 251) = 0.66$, $p>0.05$, as well as a non-significant interaction effect between the Hard v Soft and Pure v Applied disciplinary dimensions: $F(3, 251) = 0.63$, $p>0.05$.

4.4.3.6.3. Summary on collaboration

The disciplinary grouping to which respondents belonged had no bearing on the frequency with which respondents collaborated with the following groups: *researchers within respondents' university, but outside their research group; researchers within respondents' university, but outside their department/faculty*; *researchers from other universities within the UK*; and *researchers from other universities outside the UK*. However, the opposite was true when considering collaborations with *researchers within respondents' research group* whereby respondents from Hard disciplines collaborated more frequently with researchers within their research group than respondents in Both Dimensions and Soft disciplines. The were however no statistically significant differences between the Pure and Applied disciplinary groups.

4.4.4. Research outputs produced

The survey also sought to uncover the types and number of research outputs produced by researchers in the different disciplinary groups. Figs 4-24 to 4-49 show how the research outputs were represented in the disciplinary groups. ANOVA tests returned non-significant main and interaction effects, therefore statistical comparisons of the disciplinary groups could not be made.

Fig 4-24: Books – Hard v Soft

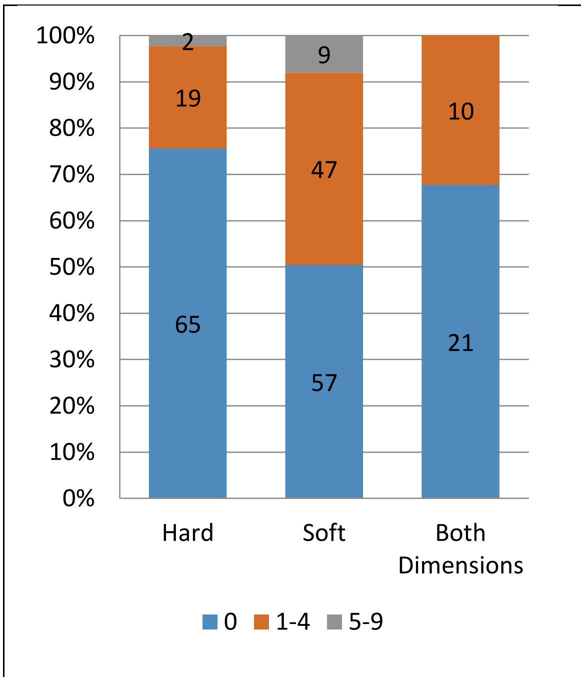


Fig 4-25: Books – Pure v Applied

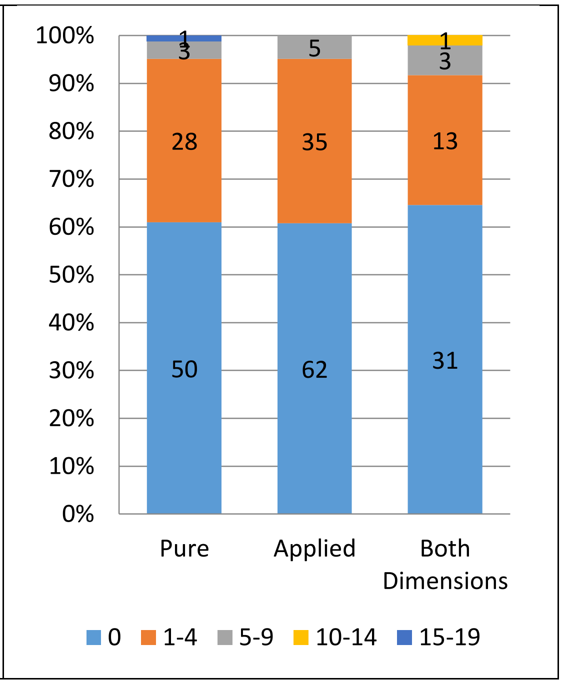


Fig 4-26: Books chapters – Hard v Soft

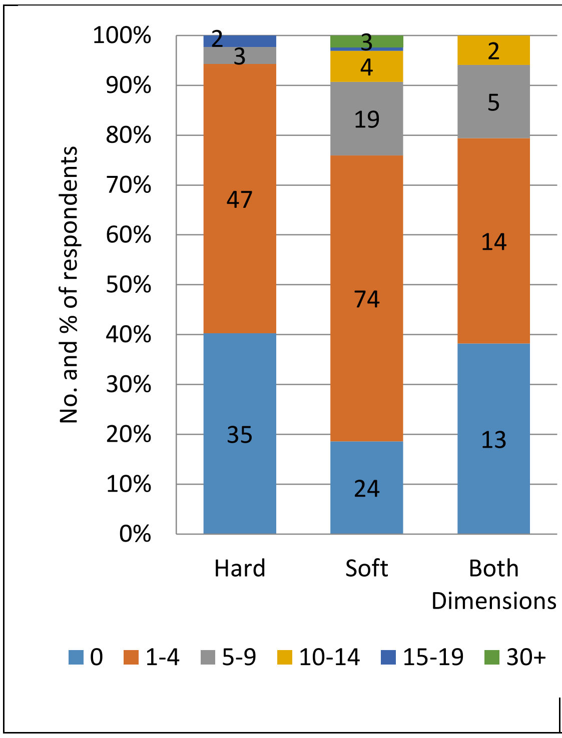


Fig 4-27: Book chapters – Pure v Applied

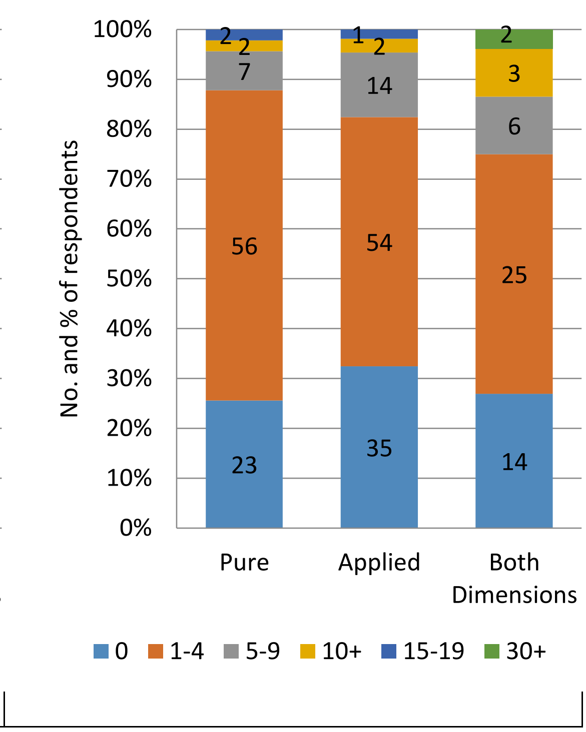


Fig 4-28: Compositions – Hard v Soft

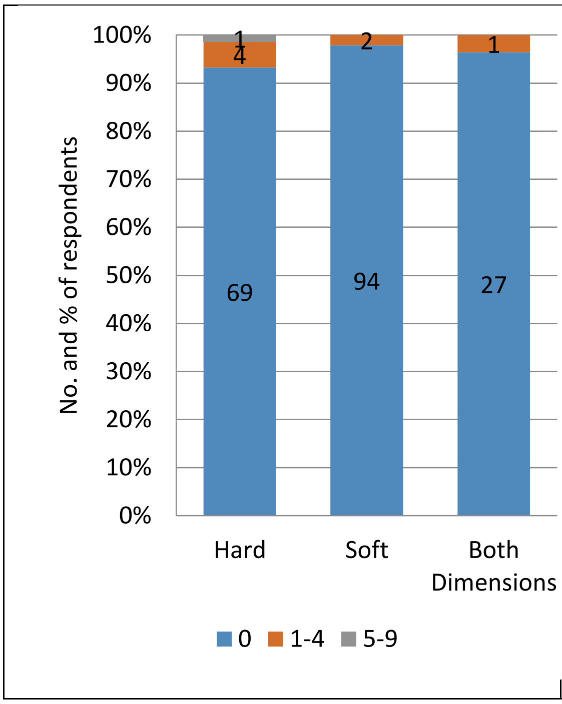


Fig 4-29: Compositions – Pure v Applied

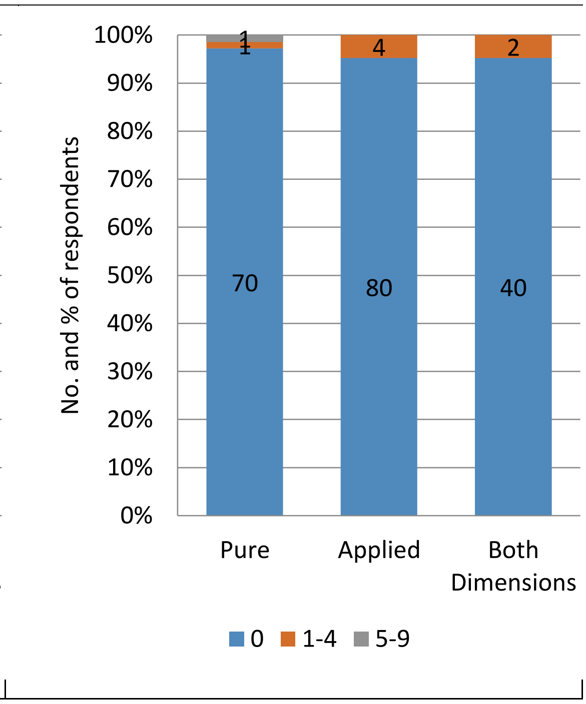


Fig 4-30: Conference contributions – Hard v Soft

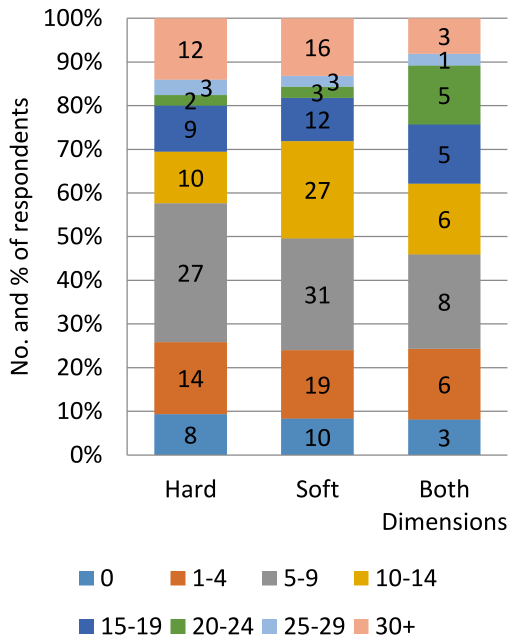


Fig 4-31: Conference contributions – Pure v Applied

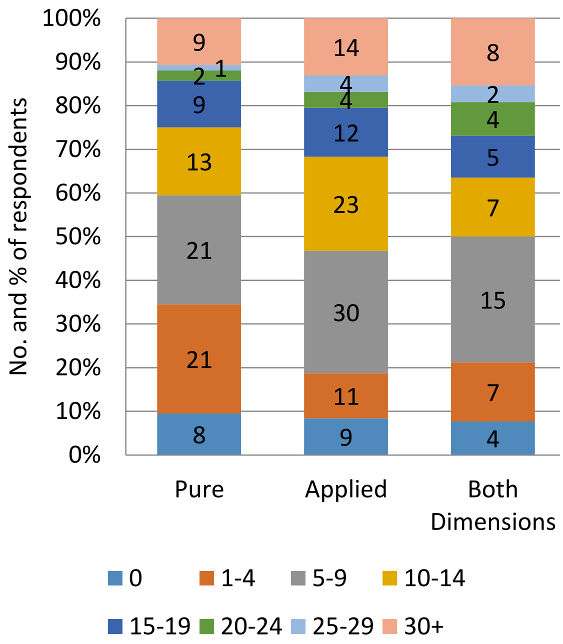


Fig 4-32: Digital/Visual media – Hard v Soft

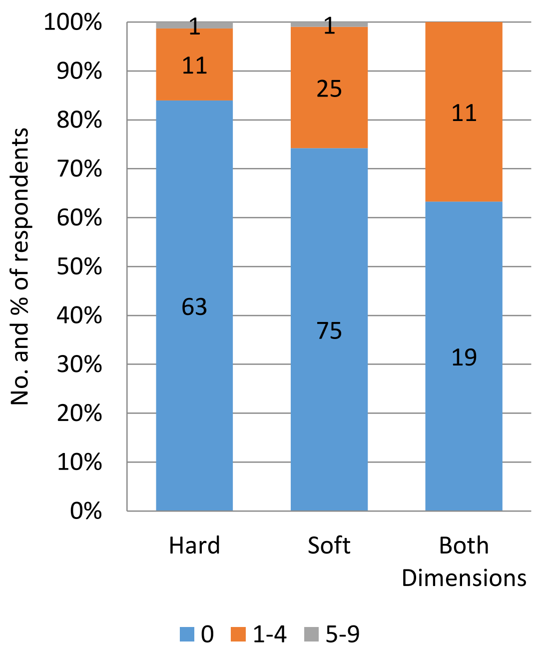


Fig 4-33: Digital/Visual media – Pure v Applied

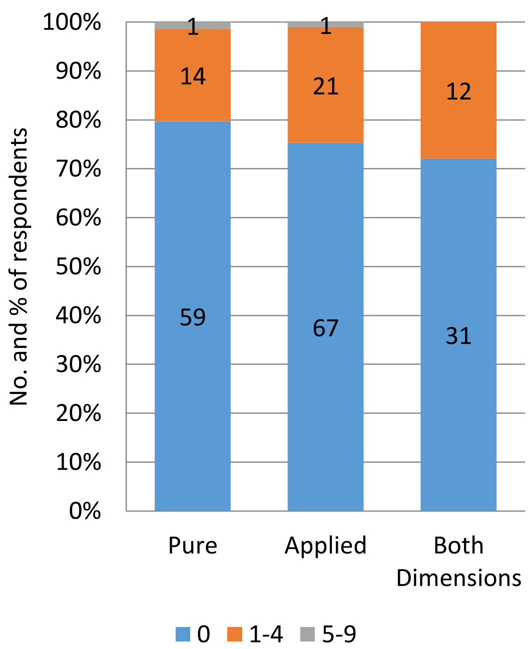


Fig 4-34: Exhibitions – Hard v Soft

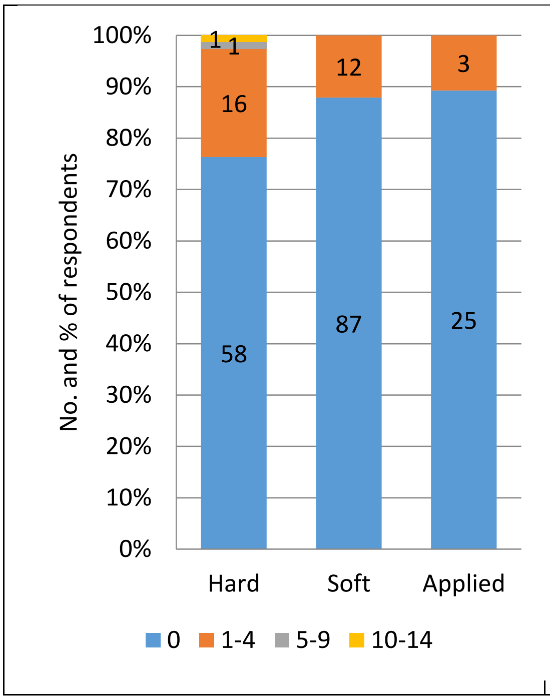


Fig 4-35: Exhibitions – Pure v Applied

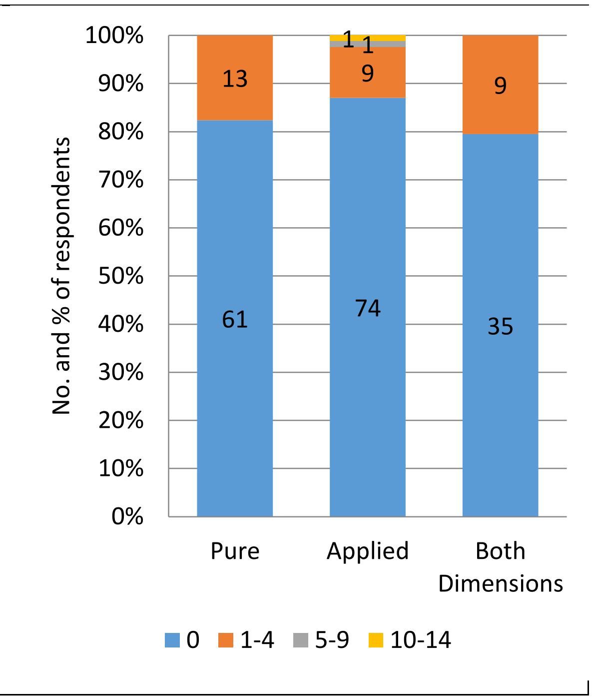


Fig 4-36: Journal articles – Hard v Soft

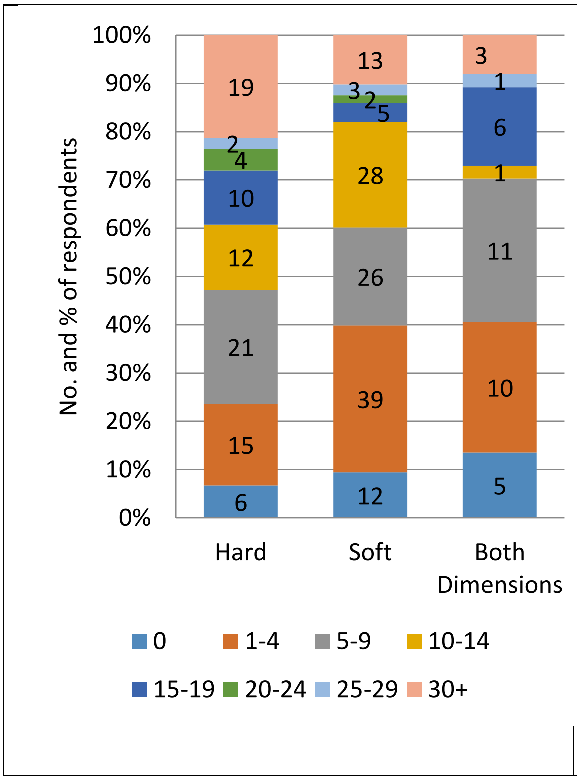


Fig 4-37: Journal articles – Pure v Applied

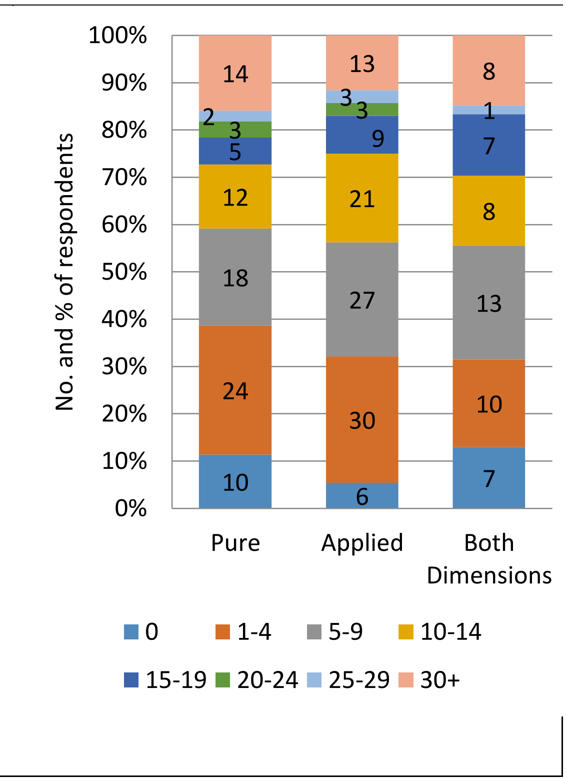


Fig 4-38: Patents – Hard v Soft

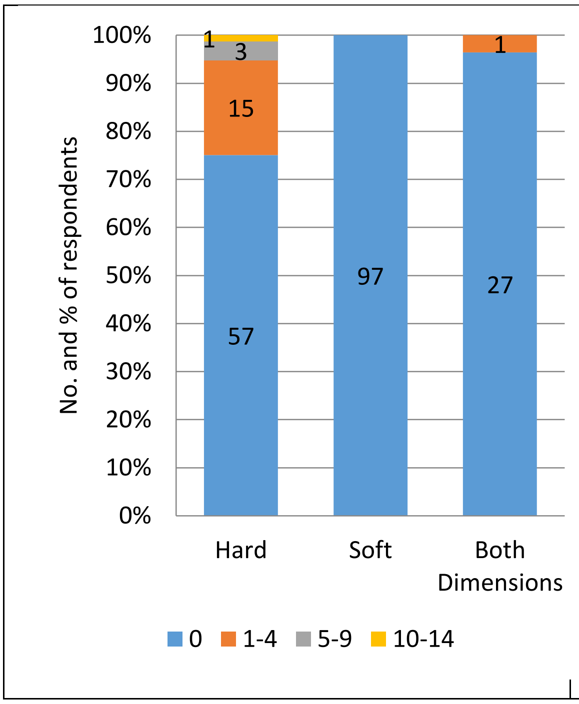


Fig 4-39: Patents – Pure v Applied

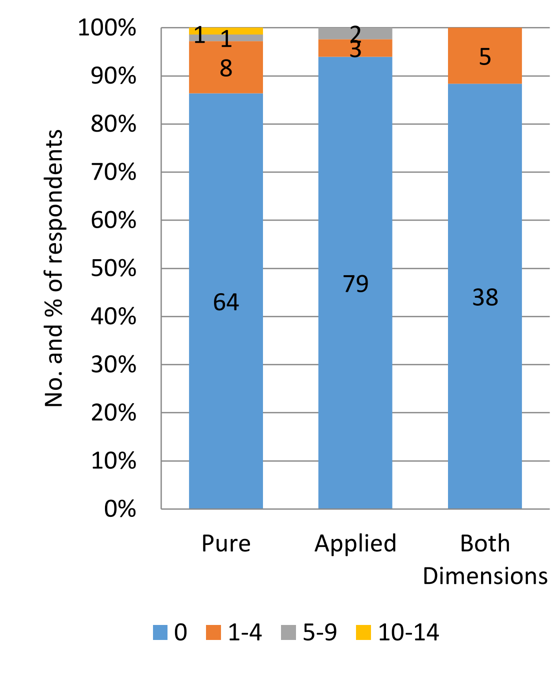


Fig 4-40: Performances – Hard v Soft

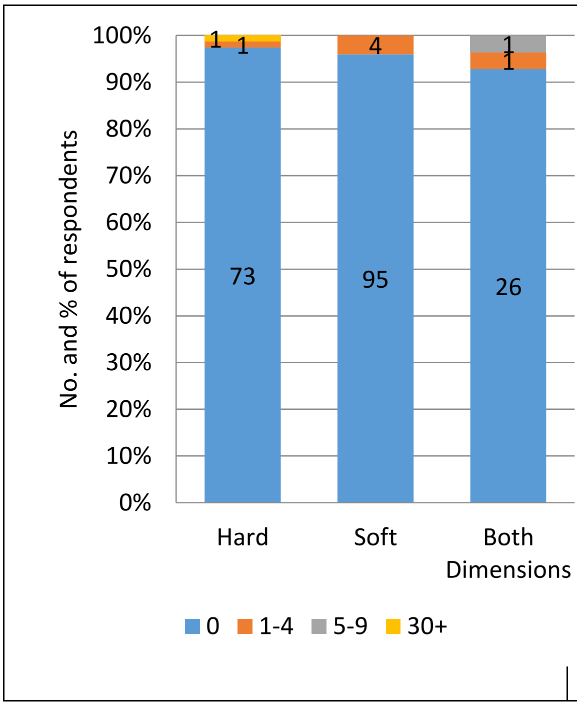


Fig 4-41: Performances – Pure v Applied

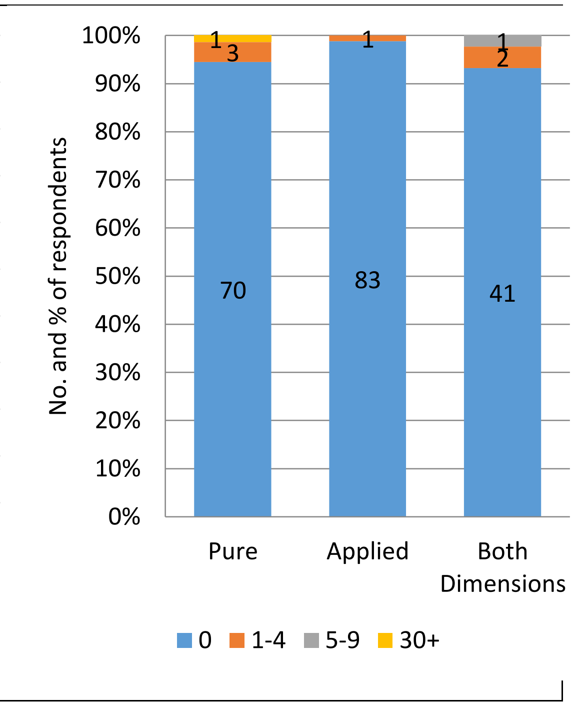


Fig 4-42: Physical artefacts – Hard v Soft

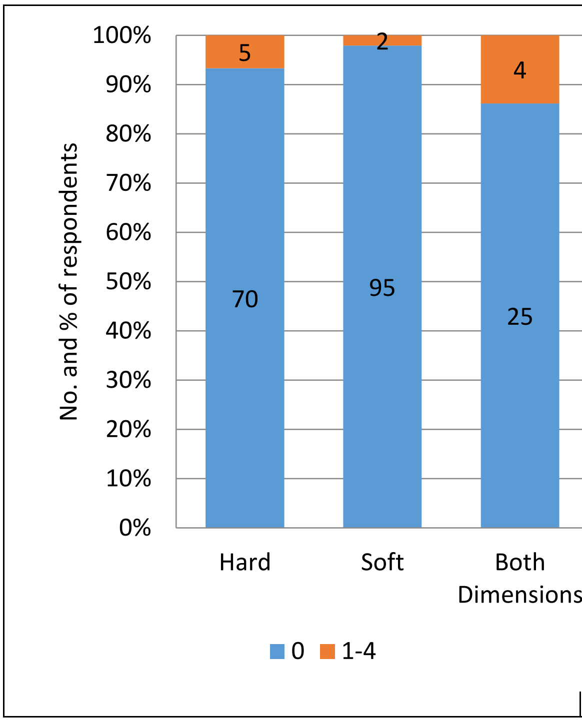


Fig 4-43: Physical artefacts – Pure v Applied

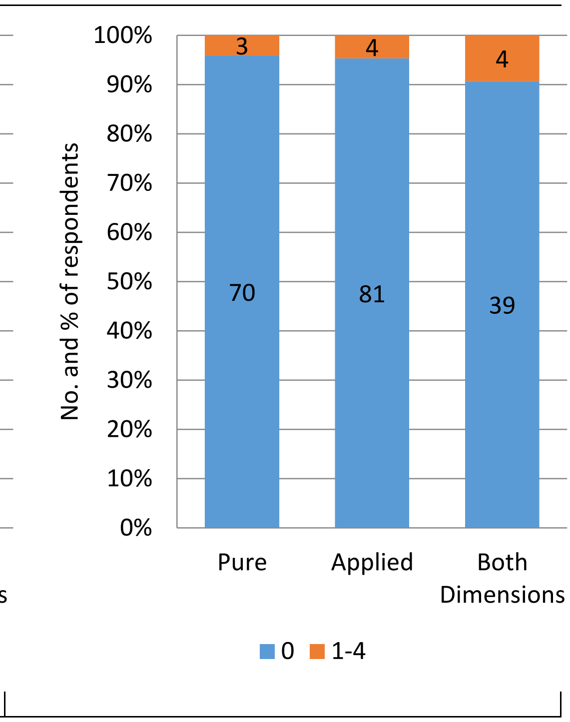


Fig 4-44: Research reports – Hard v Soft

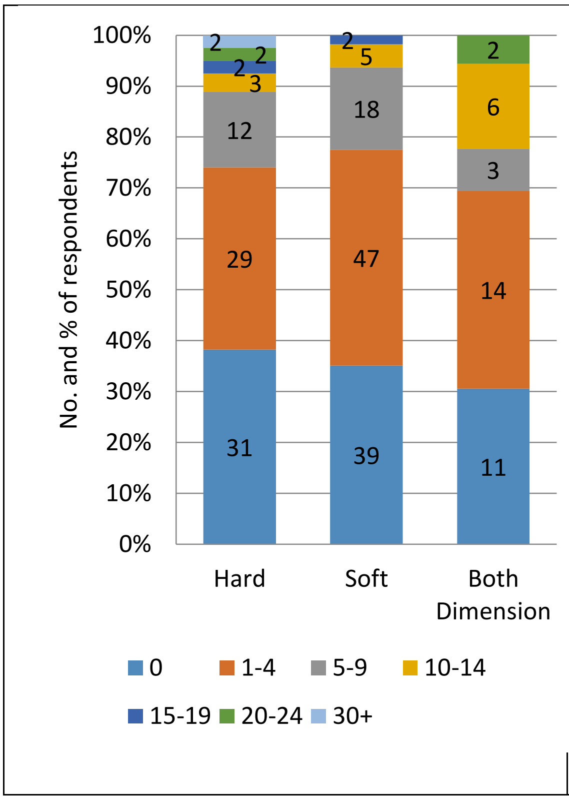


Fig 4-45: Research reports – Pure v Applied

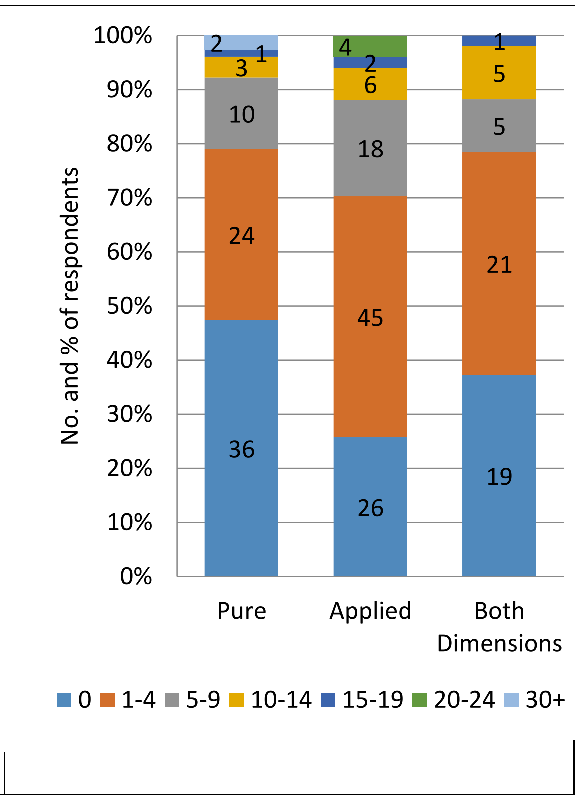


Fig 4-46: Technical reports – Hard v Soft

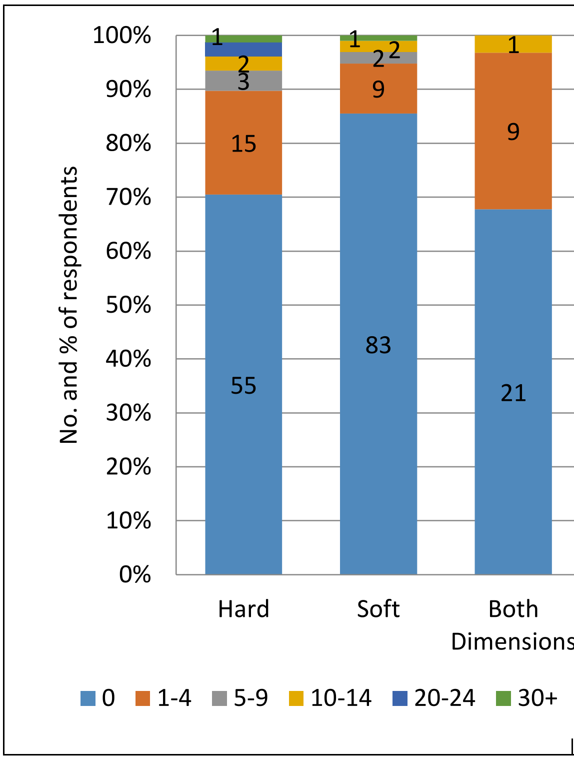


Fig 4-47: Technical reports – Pure v Applied

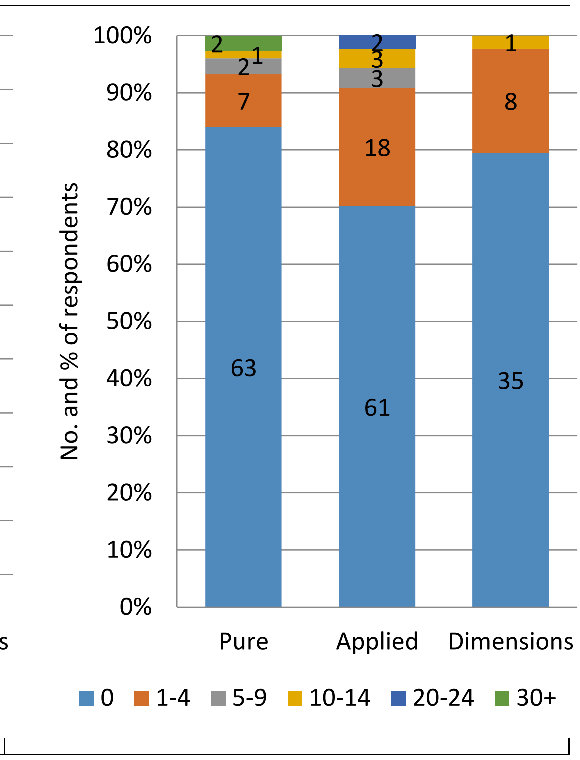


Fig 4-48: Other – Hard v Soft

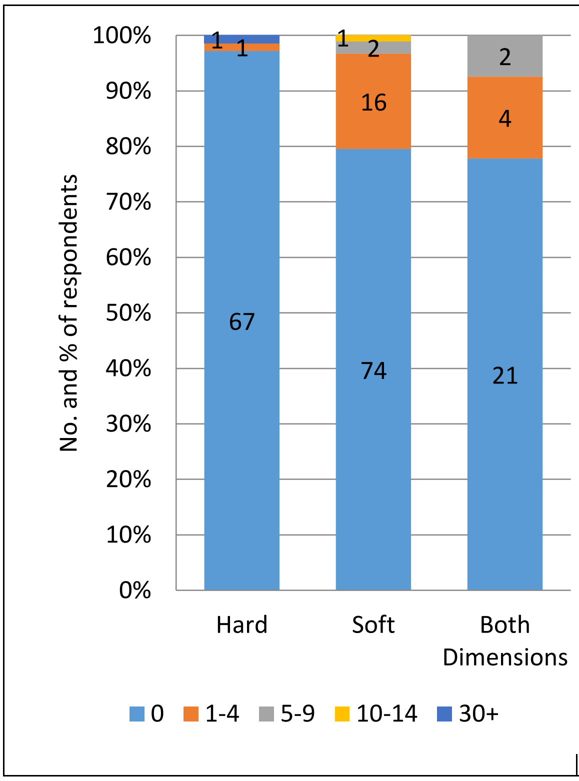
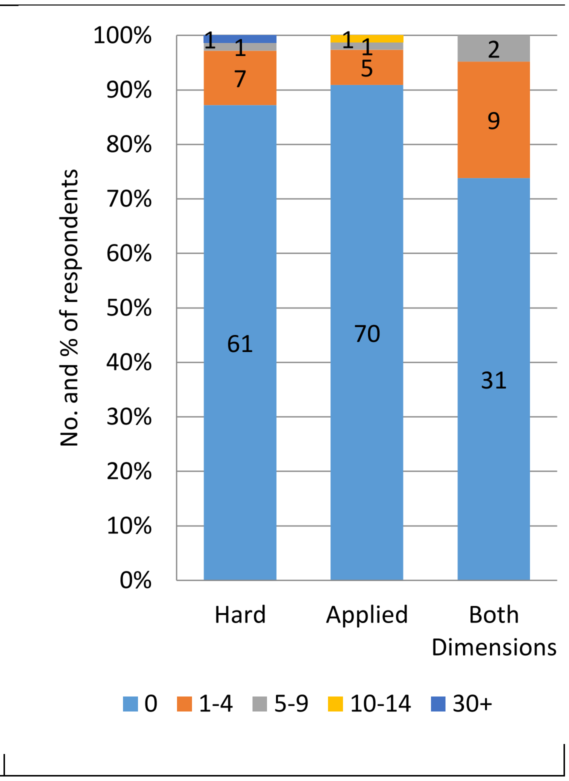


Fig 4-49: Other – Pure v Applied



4.4.4.1. Summary on research outputs produced

As stated above, ANOVA tests returned non-significant main and interaction effects, hence no statistical comparisons could between the disciplinary groups. A number of observations are apparent however; a greater proportion of respondents in Hard disciplines (75.6%) did not produce any *Books*, compared to the proportion of respondents in Soft disciplines (50.6%). There were no noticeable differences between Pure and Applied disciplines. The same trend applies to *Book Chapters* where a greater proportion of respondents in Hard disciplines (40.2%) did not produced any books, compared to the proportion in Soft disciplines (19.2%). Again, there were no noticeable differences between Pure and Applied disciplines.

At least 60% of respondents across all disciplinary groups had not produced any *Digital/Visual Media, Exhibitions, Patents, Performances, Physical Artefacts, Technical Report* output. In contrast, only less than 14.0% of the proportions of respondents across all disciplinary groups had not produced any *Conference papers*, *Journal articles* or *Research reports,* indicating that these were the three most commonly produced outputs. The interviews (section 5.5) shed more light on the research outputs valued by researchers.

4.4.5. Dissemination of research data

In this section respondents were asked questions relating to whether they had made research data openly available and their attitudes towards sharing research data. Openly available research data is defined here to encompass all the underlying results of research and by-products of research, including workflows, source code, survey responses, experimental results, transcripts, software tools etc. that have been made available anywhere on the internet.

The first question asked whether researchers had made research data openly available over the past five years, and the results are presented in Fig 4-50 below;

Figure 4-50: Q14. Over the past five years, have you made research data openly available anywhere on the internet?

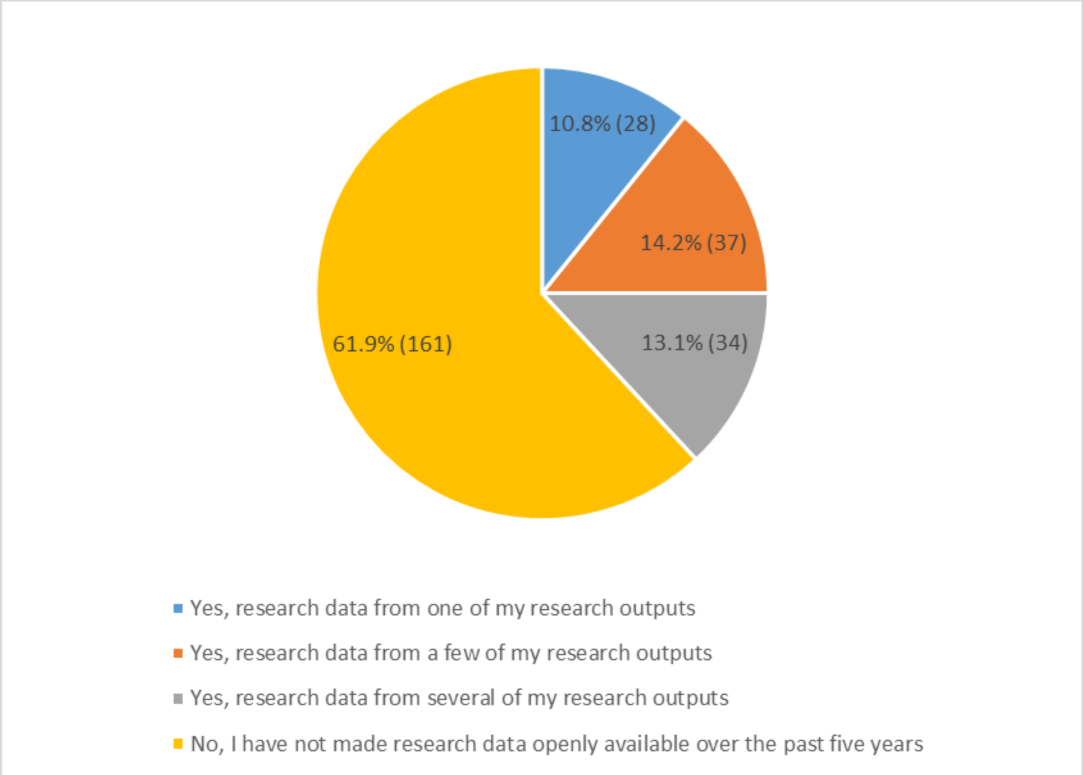


Fig 4-50 shows that the majority (61.9%) of respondents had not made their research data openly available anywhere on the internet over the past five years, whilst a total of 38.1% had made openly available data from at least one of their research outputs.

All the three 'Yes' categories above were combined in order to allow enough data in cells to perform Chi-square tests to investigate whether there was any association between respondents' disciplinary groups and whether or not they had made research data openly available. The results are as follows;

Table 4-36: Q14. Hard v Soft - Is there an association between respondents' disciplinary groups and whether or not they had made research data openly available?

	HARD v SOFT		
	Made data openly available? Yes	Made data openly available? No	Total
Hard	39 (42.9%)	52 (57.1%)	91 (100%)
Soft	43 (32.8%)	88 (67.2%)	131 (100%)
Both Dimensions	17 (44.7%)	21 (55.3%)	38 (100%)
Total	99 (38.1%)	161 (61.9%)	260 (100%)

There was no significant association between the Hard, Soft and Both Dimensions disciplinary groups, and whether or on not respondents had made their research data openly available (Chi-square=3.13, df=3, p>0.05) (Table 4-36).

There were however disciplinary differences when comparing Pure v Applied disciplines. Chi-square tests showed that there was an association between the Pure, Applied and Both Dimensions disciplinary groups, and whether or not respondents had made their research data openly available (Chi-square=7.189, df=2, p<0.05).

Table 4-37: Q14. Pure v Applied - Is there an association between respondents' disciplinary groups and whether or not they had made research data openly available?

PURE v APPLIED			
	Made data openly available? Yes	Made data openly available? No	Total
Pure	41 (45.6%)	49 (54.4%)	90 (100%)
Applied	33 (28.9%)	81 (71.1%)	114 (100%)
Both Dimensions	25 (44.6%)	31 (55.4%)	56 (100%)
Total	99 (38.1%)	161 (61.9%)	260 (100%)

Table 4-37 shows that, the Applied disciplinary group had the smallest proportion (28.9%) of respondents who had made their research data openly available, compared to those in the Pure (45.6%) and Both Dimensions (44.6%) disciplinary groups. This implies that researchers from the Applied disciplinary group were less likely to make their data openly available compared to those in the Pure or Both dimensions disciplinary groups.

4.4.5.1. Research funding and research data dissemination

The survey enabled the investigation of any potential association between whether or not researchers made their research data available and how frequently they carried out research that required external funding as shown in Table 4-38 below:

Table 4-38: Is there an association between carrying out research that requires external funding, and making research data openly available?

How frequently do you carry out research that requires external funding?	Made data openly available? Yes	Made data openly available? No	Total
Almost always	45 (42.5%)	61 (57.5%)	106 (100%)
Frequently	27 (38.0%)	44 (62.0%)	71 (100%)

Occasionally	22 (33.3%)	44 (66.7%)	66 (100%)
Never	5 (29.4%)	12 (70.6%)	17 (100%)
Total	99 (38.1%)	161 (61.9%)	260 (100%)

Although there appears to be a trend in Table 4-38 whereby making research data openly available increases with the frequency of carrying out research requiring external funding, this was not found to be statistically significant. In other words, there was no association between whether or not respondents had made their research data openly available over the past five years and how frequently they carried out research that required external funding (Chi-square=2.03, df=3, $p>0.05$).

4.4.5.2. Types of data made openly available

Respondents were also asked which types of research data they had made openly available. Of the 99 respondents who stated that they had made their research data openly available (see Table 4-38), 94 gave details of the types of data they had made openly available.

Figure 4-52: Q15. Please indicate if you have made any of the following openly available (n=94)

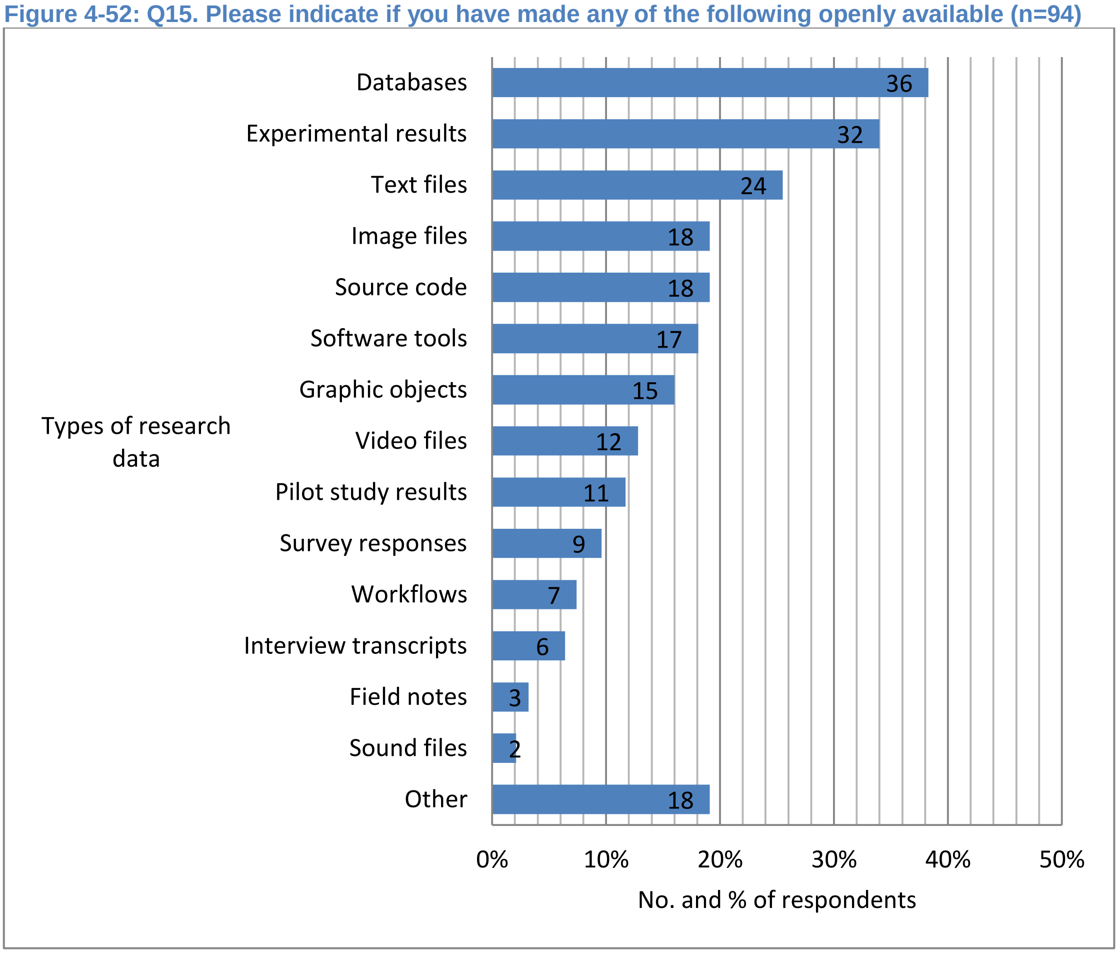


Fig 4-52 reveals that the most common type of research data made openly available was databases (38.3%), followed by experimental results (34.0%). The results also show differences in the types of data that constitute multimedia content: the most commonly shared being text files (25.5%) and the least shared being sound files (2.1%); with others; (image files (19.1%), graphic objects (16.0%), video files (12.8%) falling in between.

4.4.5.3. Locations in which research data has been uploaded

The next question entailed uncovering which locations respondents had uploaded their research data (Fig 4-52).

Figure 4-53: Please indicate in which of the following locations you have uploaded research data (n=99)

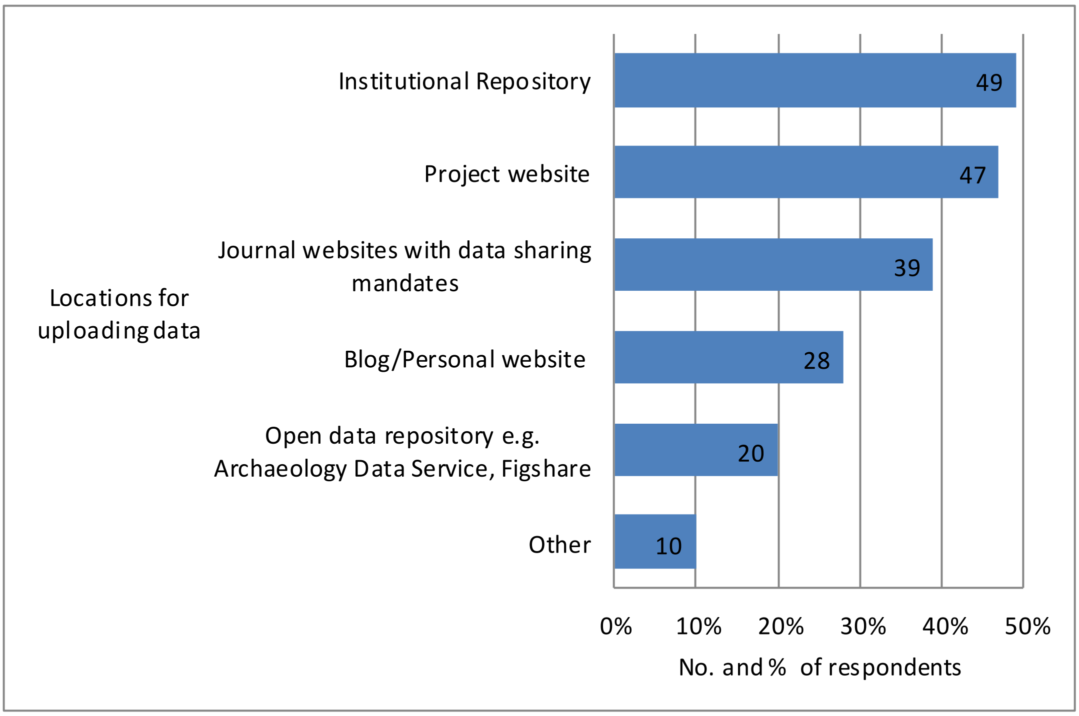
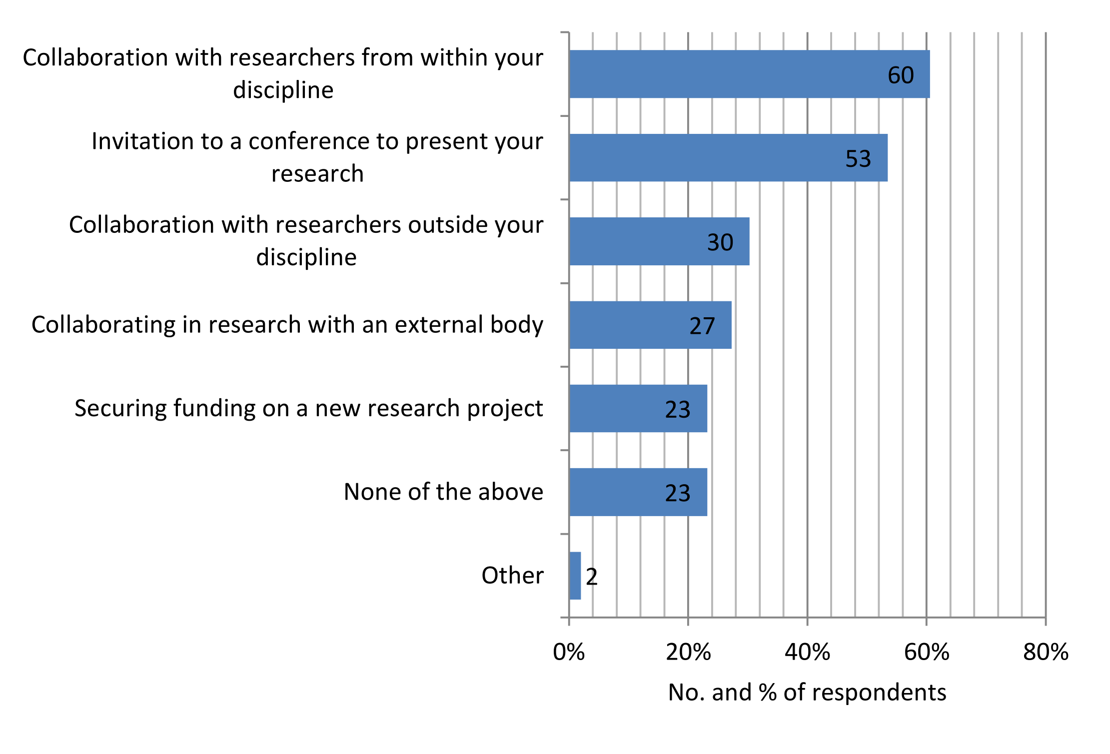


Figure 4-53 shows that the most common locations for uploading research data were the institutional repository (49.5%) and project website (47.5%). It can also be seen how open data repositories were not a common location for uploading research data, as indicated by only a fifth of respondents (20.2%) who uploaded their research data on open data repositories.

4.4.5.4. Benefits from making research data openly available

Respondents were asked if they had experienced any benefits as a result of making their research data openly available (Fig 4-54).

Figure 4-54: Q18. Please select whether you have experienced any of the following as a result of making your research data openly available (n=99)

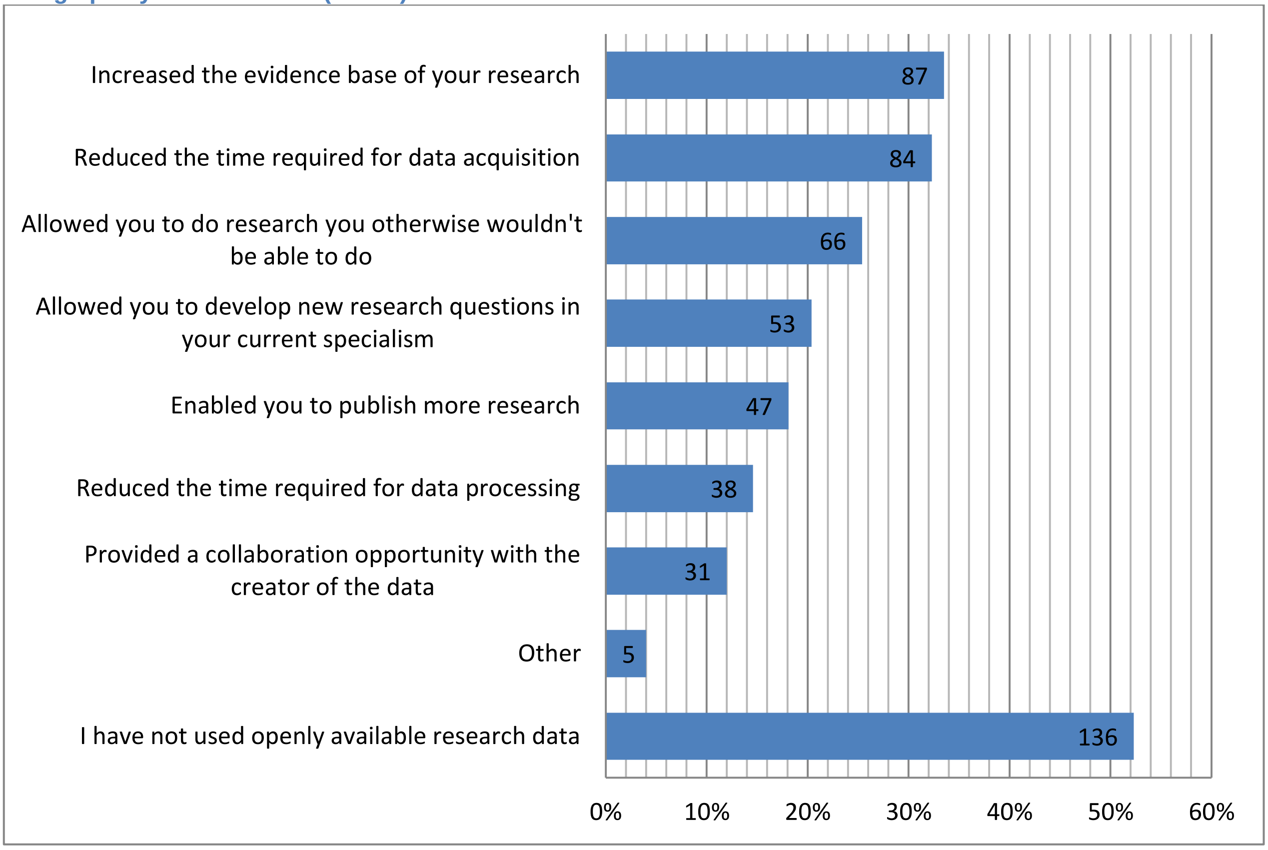


Of the 99 researchers who had made their research data openly available, the most common realised benefit was that sharing their data had presented them with the opportunity for collaboration with researchers *within their discipline* (60.6%). This can be compared with 30.3% who stated that it led to an opportunity to collaborate with researchers *outside their discipline*. Moreover, such benefits not only stemmed from other researchers, but also from non-academic audiences - just over a quarter (27.3%) of respondents noted that sharing their research data led to opportunities for collaborating with an external body such as a charity organisation or local government.

4.4.5.5. Benefits from using openly available research data

In a reversal of roles, researchers were also asked whether they had experienced any benefits as a result of *using* openly available research data (Fig 4-55).

Figure 4-55. Q19. Please indicate whether you have experienced any of the following as a result of using openly available data (n=260)



The majority of respondents (52.3%) had not used openly available research data, whilst 33.5% of respondents reported how using openly available research data had *increased the evidence base of their research*. Just over a tenth of respondents (12.0%) stated that they had benefitted from a *collaboration opportunity with the creator of the data* as resulting of using openly available research data.

4.4.5.6. Attitudes towards research data sharing

Figs 4-56 to 4-60 show responses of the extent to which respondents agreed with five set statements on attitudes towards sharing research data. ANOVA tests did not show any disciplinary differences for the following four statements;

- Putting my research data in the public domain may result in it being misinterpreted or misreported
- I may need to use the data in future, so making it openly available too soon may reduce the value of my future research
- I often do not have the time to organise the data and make it openly available

- As the creator of the data, I fear that the data may be used without due acknowledgement.

The responses to the above statements are presented in Figs 4-56 to 4-59 below;

Figure 4-56: Q17. Putting my research data in the public domain may result in it being misinterpreted or misreported

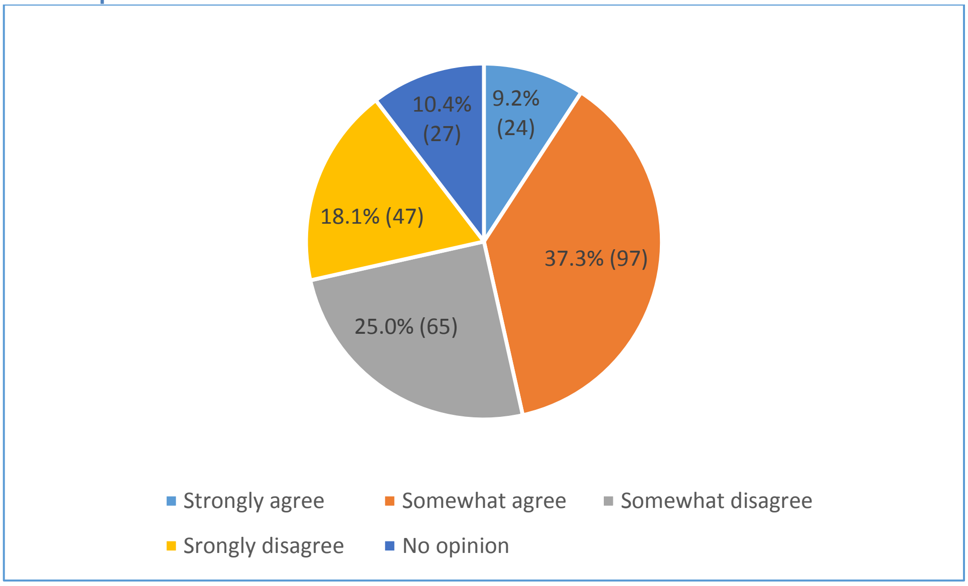


Figure 4-57: Q17. I may need to use the data in future, so making it openly available too soon may reduce the value of my future research

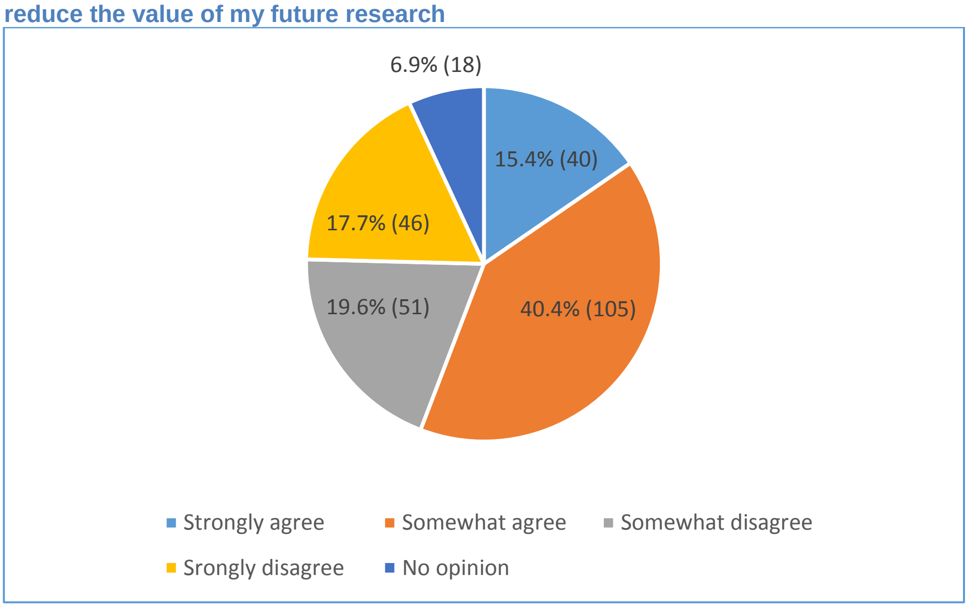


Figure 4-58: Q17. I often do not have the time to organise the data and make it openly available

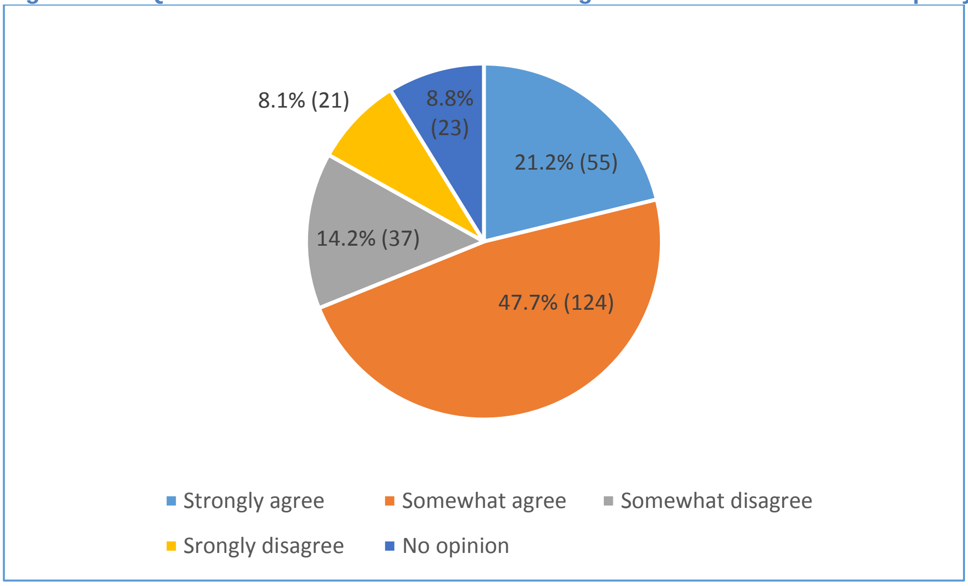
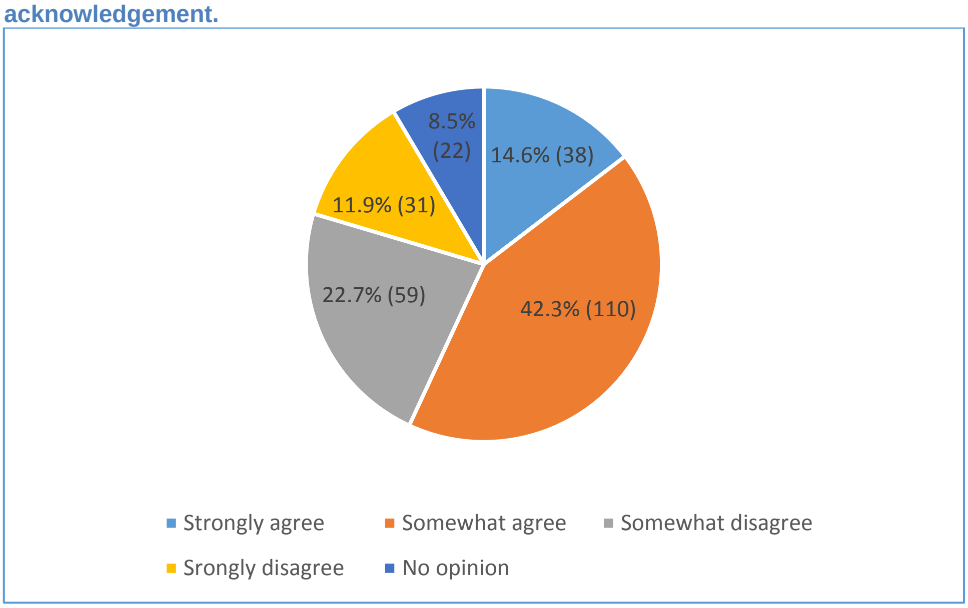


Figure 4-59: Q17. As the creator of the data, I fear that the data may be used without due acknowledgement.



Altthough as stated above, ANOVA tests did not show any disciplinary differences on the above statements, two points can be noted; the highest number of 'strongly agree' responses were from about a fifth of researchers (21.2%) who often did not have time to organise research data and make it openly available (Fig 4-58). This can be contrasted with the highest number of 'strongly disagree' (18.1%) responses to the statement; '*Putting my research data in the public domain may result in it being misinterpreted or misreported'* (Fig 4-56).

The only statement in the question to show disciplinary differences statistically was; '*Most of the data I produce is of a confidential nature therefore cannot be made openly available'* (Fig 4-60).

Fig 4-60: Q17. Most of the data I produce is of a confidential nature therefore cannot be made openly available

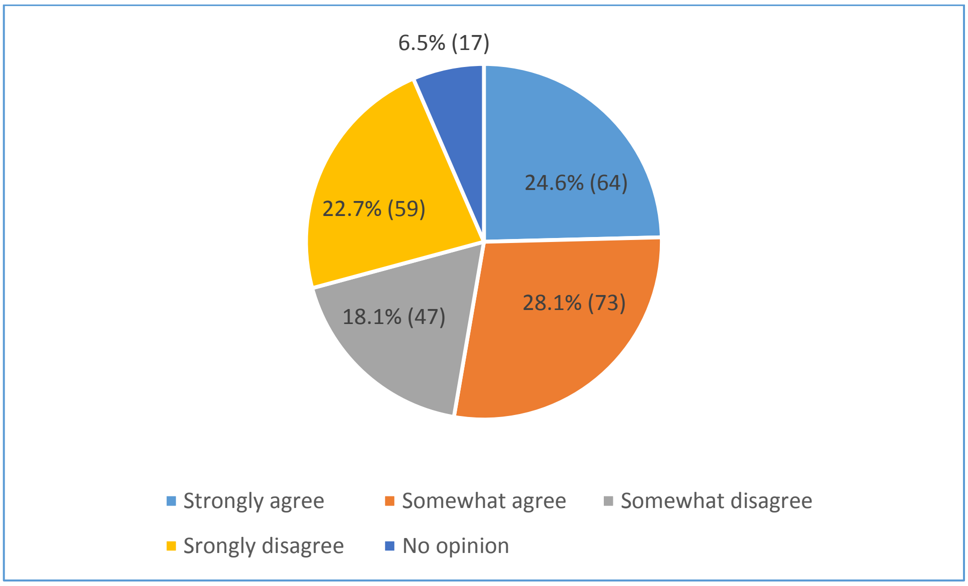


Table 4-38 show the results in Fig 4-60 broken down to show disciplinary differences between the Hard, Soft and Both groups. A greater proportion of respondents in the Both Dimensions disciplinary group (74.3%) either strongly or somewhat agreed that not making their research data openly available was due to its confidential nature. This can be compared to those in the Soft disciplinary group (56.9%). Respondents from the Hard disciplinary group seem to have an almost balanced opinion on this; i.e. 48.2% who either strongly or somewhat agreed versus 51.8% who either strongly disagreed or somewhat disagreed.

Table 4-38: Q17. Hard v Soft - Disciplinary differences in attitudes towards confidentiality of research data

	HARD v SOFT					Total
	Strongly agree	Somewhat agree	Somewhat disagree	Strongly disagree	No opinion	
Hard	21 (23.1%)	20 (22.0%)	18 (19.8%)	26 (28.6%)	6 (6.6%)	91 (100%)
Soft	32 (24.4%)	38 (29.0%)	25 (19.1%)	28 (21.4%)	8 (6.1%)	131 (100%)
Both dimensions	11 (28.9%)	15 (39.5%)	4 (10.5%)	5 (13.2%)	3 (7.9%)	38 (100%)
Total	64 (24.6%)	73 (28.1%)	47 (18.1%)	59 (22.7%)	17 (6.5%)	260 (100%)

Looking at the Pure v Applied comparison; Table 4-39 below shows a marked contrast between the Pure and Applied disciplinary groups; whereas the majority of respondents in the Applied disciplinary group (67.0%) did not make research data openly available because of its confidential nature, this can be compared to only a minority of those in the Pure disciplinary group (38.6%). Moreover, researchers in the Both Dimensions group seemed to be aligned with those in the Applied disciplinary group as a majority of them (62.7%) did not make research data openly available because of its confidential nature. This implies that researchers in the Applied and Both Dimensions disciplinary groups seem to view confidentiality as a major barrier for sharing research data more than those in the Pure disciplinary group.

Table 4-39: Q17. Pure v Applied - Disciplinary differences in attitudes towards confidentiality of research data

	PURE v APPLIED					Total
	Strongly agree	Somewhat agree	Somewhat disagree	Strongly disagree	No opinion	
Pure	15 (16.7%)	17 (18.9%)	20 (22.2%)	31 (34.4%)	7 (7.8%)	90 (100%)
Applied	34 (29.8%)	39 (34.2%)	19 (16.7%)	17 (14.9%)	5 (4.4%)	114 (100%)
Both dimensions	15 (26.8%)	17 (30.4%)	8 (14.3%)	11 (19.6%)	5 (8.9%)	56 (100%)
Total	64 (24.6%)	73 (28.1%)	47 (18.1%)	59 (22.7%)	17 (6.5%)	260 (100%)

An ANOVA test showed a non-significant main effect of the Hard v Soft disciplinary group $F(2,252) = 2.59$, $p>0.05$ on *confidentiality* as a barrier for not sharing research data. There was however a significant main effect for the Pure v Applied disciplinary group $F(2, 252) = 9.13$, $p<0.05$; respondents in Applied disciplines (M=2.30, SD=1.24) viewed *confidentiality* as a barrier more than respondents in Both Dimensions (M=2.54, SD=1.32) and Pure disciplines (M=2.98, SD=1.24). There was a non-significant interaction effect $F(3, 252) = 0.79$, $p>0.05$ between the Hard v Soft and Pure v Applied disciplinary groups.

4.4.6. Public engagement activities

Respondents were asked if they had taken part in any public engagement activities over the past five years. The following statement by RCUK (n.d.) was used to define public engagement as: "*any activity that engages the public with research, from science communication in science centres or festivals, to* *consultation, to public dialogue.*" 79% (205) of respondents indicated that they had undertaken so and tests were performed to investigate whether there was an association between the disciplinary group to which one belongs and whether or not they are likely to take part in a public engagement activity (Fig 4-62).

Fig 4-62: Q20: Public engagement activities and disciplinary groups

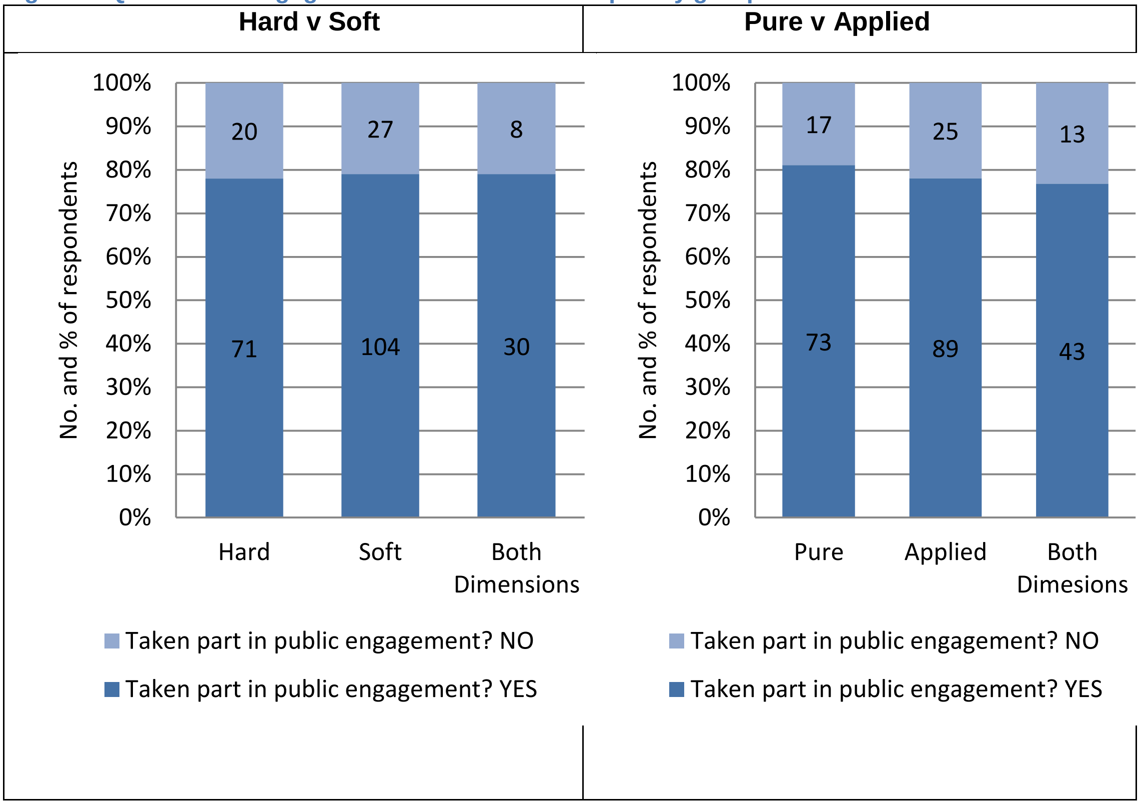


Fig 4-62 shows no notable differences in public engagement activity across the Hard v Soft and Pure v Applied disciplinary groups. Chi-square tests supported this, and showed that there was no significant association (Chi-square=0.06, df=2, $p>0.05$) between the Hard v Soft disciplinary groups and participation in public engagement activities. Equally, there was no significant association (Chi-square=0.46, df=2, $p>0.05$) between Pure v Applied disciplinary groups and whether respondents had taken part in any public engagement activity. From the two tests, a conclusion can therefore be drawn that there is no significant association between the disciplinary group to which one belongs and whether or not they have taken part in public engagement.

4.4.6.1. Types of public engagement activities

Respondents were then asked to the question; '*Please indicate if you have been involved in any of the following activities as a way of communicating your research to audiences outside the academic community'.* The results are shown in Fig 4-64 below;

Fig 4-64: Q21. Public engagement activities undertaken by researchers (n=205)

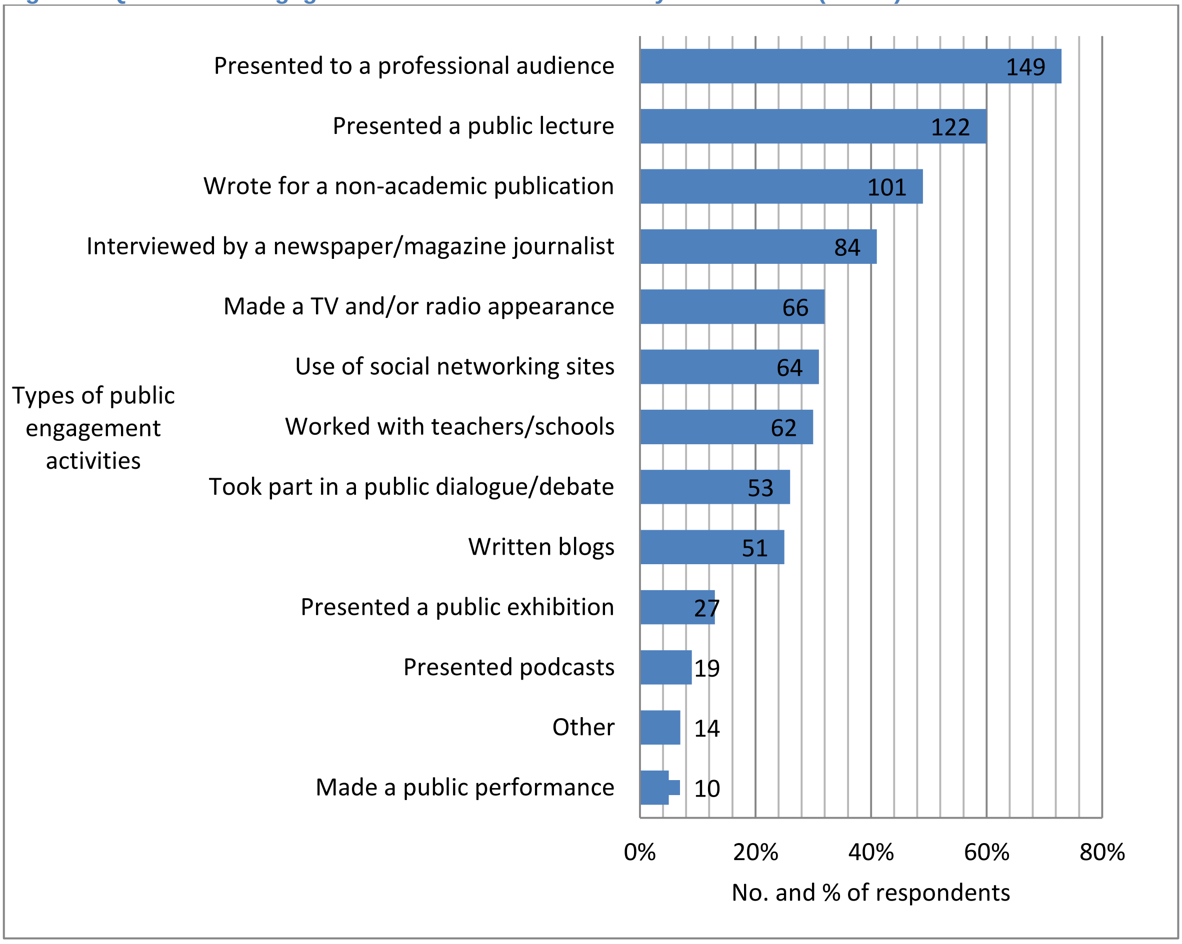


Fig 4-64 indicates that almost three quarters (73%=149/205) of respondents had 'presented to a professional audience', with 60% presenting a public lecture over the past five years. The graph also shows that almost a third (30%) of respondents were involved in community-based engagement such as working with schools, whilst other engagement activities were through use of some form of media such as writing in non-academic publications (49%) or writing blogs (25%).

4.4.6.2. Barriers to undertaking public engagement activities

The remaining 21% (55) of respondents who had not undertaken any form of public engagement activity were asked to state any barriers that prevented them doing so. Twenty-four provided responses as shown in Table 4-40 below:

Table 4-40: Q21. Barriers to taking part in public engagement

Because I've just start it, less than one year ago, it is too soon.
Don't have a chance, but I want to do it.
I have only started my research in the past 4 months so I have no data to disseminate
I'm not sure there is a general public interest in my research, which has to do with education.
Insufficient time / not a priority for my institution
It wasn't high on the agenda (but it is now!)
Lack of funding, and unsuitability of subject matter
Lack of time
Lack of time due to other commitments
Lack of time/opportunity, not opposition in principle.
Mostly no, other than social media, which has had a very limited sphere. Public engagement (outside of research dissemination) was not within the research project plan, so no time allocated.
My research is quite mathematical and theoretical, and I consider it to be of limited interest for public engagement activities. I take part in public engagement activities (such as outreach talks), but the content of these activities does not specifically relate to my research.
No opportunities
No opportunity arose
No opportunity to do so.
Not had the opportunity yet
Not invited or suggested!
not suitable
not yet had opportunity, still in early stages of work
Specialist nature of research
Talking through my research with a sample of people my research is aimed at (not participants). Patient & Public Involvement. Summed up research and ideas on a personal blog. Shared teaching materials and online tutoring.
the research is typically early stage, fundamental science and not immediately relevant for public engagement
Time and opportunity
Too early in my research

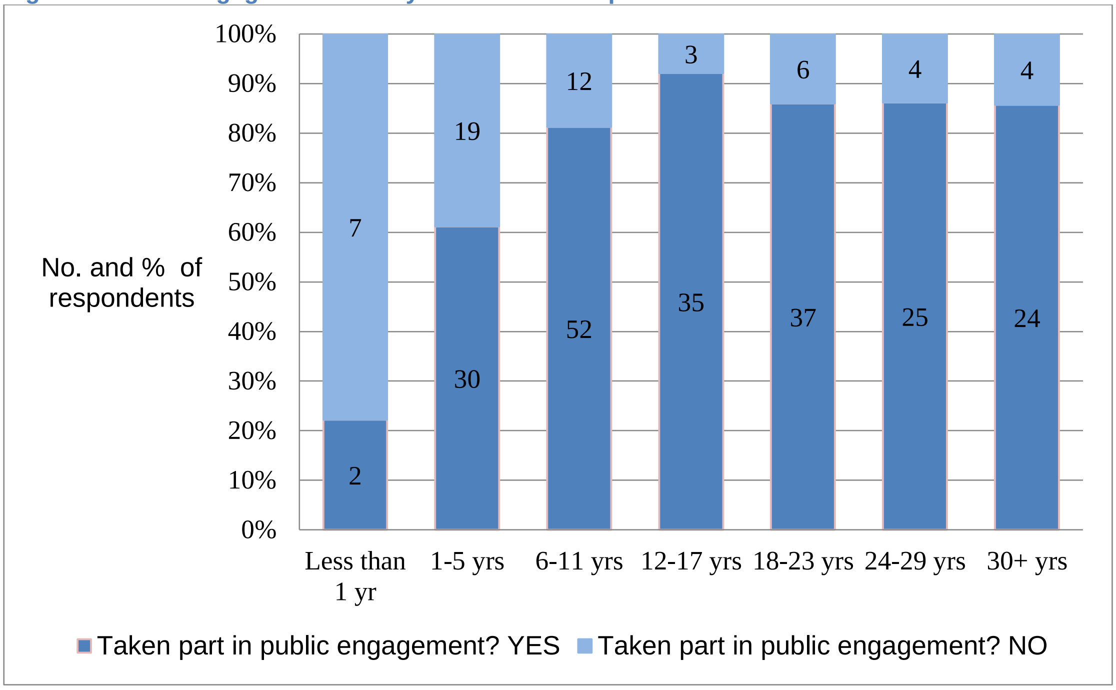
An analysis of Table 4-40 reveals four common barriers to undertaking public engagement activities. Firstly, of the 24 responses about a third (33.3%) of respondents pointed to '*lack of opportunity*' as the reason why they had not undertaken any public engagement activity over the past five years. In addition, the '*specialist nature of research/lack of public interest'* was identified by about a fifth of respondents (20.8%) of the respondents, as one respondent stated: *"My research is quite mathematical and theoretical, and I consider it to be of limited interest for public engagement activities*..." It seems some respondents felt that the subject content of their research would not be easy to relay to non-specialist audiences, therefore not finding much motivation in taking part in any public engagement.

Matching the proportion of responses to *specialist nature of research/lack of public interest'* was '*lack of time'* (20.8%). Lack of time suggests that possibly due to competing demands of research, teaching, administrative and other academic activities, not much time is left then for academics to focus on public engagement. Lastly, the other barrier noted was *'too early in research career stage'* (16.7%). This suggests that as one becomes more experienced in their research career, the higher the likelihood of them taking part in public engagement; this is investigated in sub-section 4.4.6.3 below.

4.4.6.3. Association between researchers' years of research activity and involvement in public engagement activities?

Fig 4-65 below shows the proportions of researchers who took part in public engagement based on their research experience.

Fig 4-65: Public engagement activity and research experience



The first two categories shown above, 'Less than 1 year' and '1-5 years' were combined in order to allow enough data in cells to perform Chi-square tests. The tests showed that there was an association (Chi-square 26.79, df=2, $p<0.05$) between researchers' years of research activity and whether or not they had undertaken any public engagement activity. The results show a general trend of the proportion of researchers who took part in public engagement activities increasing in the successive categories of years of research activity. There was a notable peak in the '12-17 years' category, where 92.1% of respondents had taken part in some form of public engagement activity; this slightly reduced to 85.7% in the '30+ years' category which represents the most experienced of researchers.

4.4.6.4. Motivators for undertaking public engagement activities

Respondents were asked to rate six statements in terms of how important each was in motivating them to take part in public engagement activities (Figs 4-66 to 4-71).

Fig 4-66: Q23. To be accountable and transparent

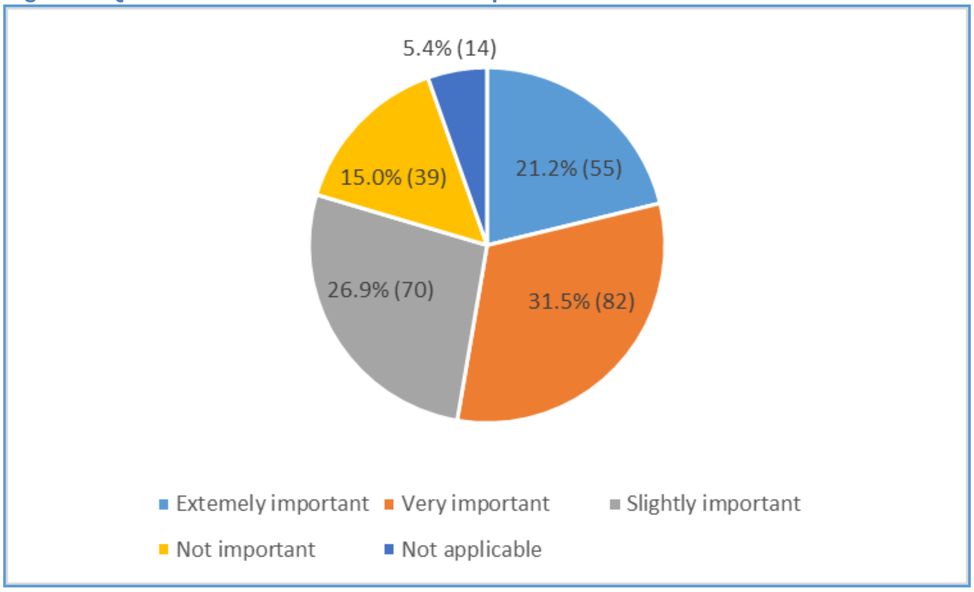


Fig 4-67: Q23. To inspire learning

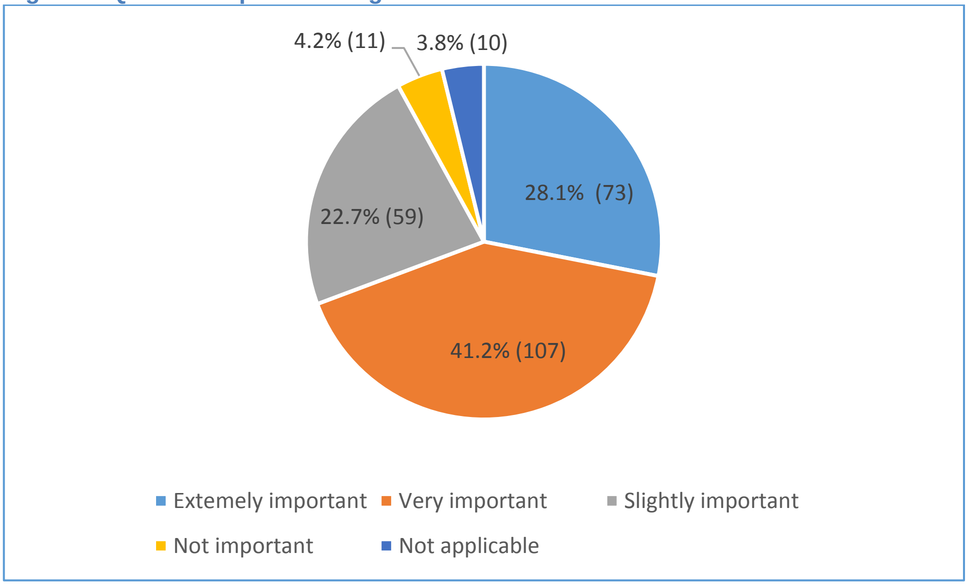


Fig 4-68: Q23. To enhance my career

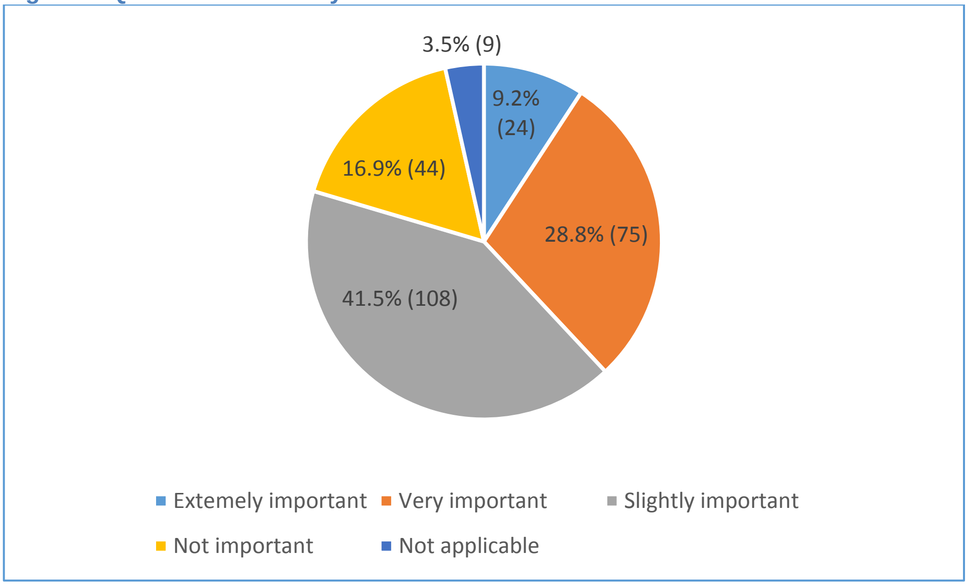


Fig 4-69: Q23. To win support for my research area

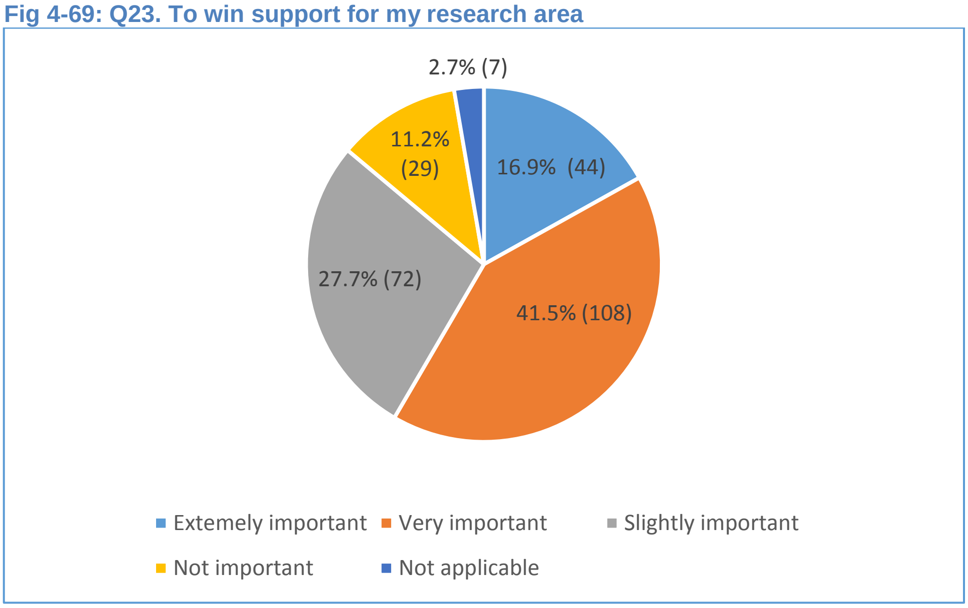


Fig 4-70: Q23. To influence policy decisions

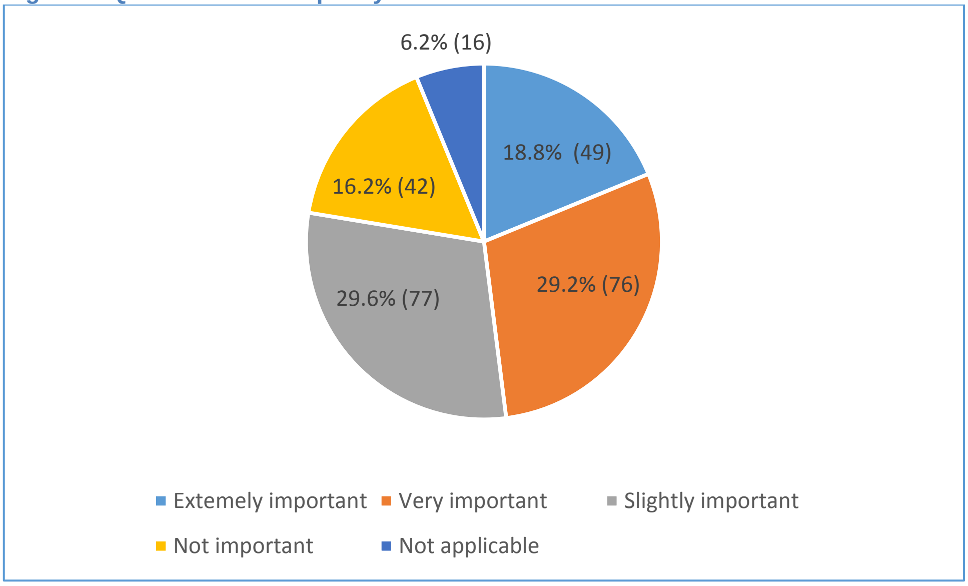
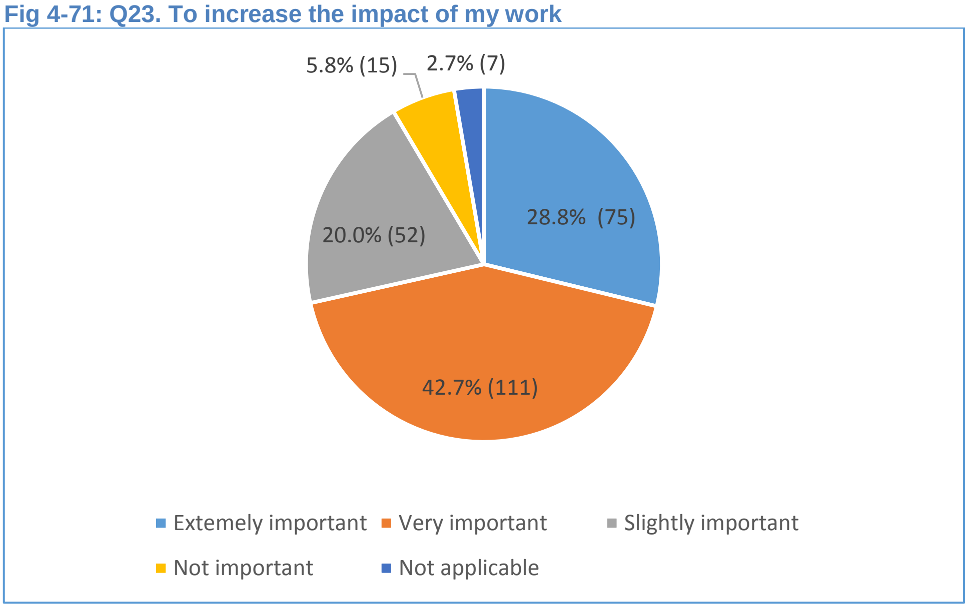


Fig 4-71: Q23. To increase the impact of my work



4.4.6.4.1. Summary of Figs 4-66 to 4-71.

The most highly rated motivators for taking part in public engagement activities was '*to increase the impact of my work'* and *'to inspire learning'*, based on the proportion of who respondents stated that these were either 'extremely important' or 'very important', 71.5% and 69.3% respectively. This can be contrasted with only 38.0% of respondents who regarded *enhancing their career* as either extremely important or very important in motivating them to take part in public engagement activities. The results also show that *gaining support of one's research area* is a highly rated motivator for taking part in public engagement activities, as almost three-fifths (58.4%) of respondents rated it as either extremely important or very important. Respondents were almost evenly divided when asked about how important *influencing policy decisions* was as a motivator for taking part in public engagement activities, as shown by those who answered either extremely important or very important (48.0%), compared to those who answered either slightly important or not important (45.8%).

Respondents were also asked if there any other reasons that motivated them to take part in public engagement activities. Table 4-41 shows the responses:

Table 4-41: Q24. Motivators for taking part in public engagement

Appropriate training opportunities
Change the world!
Complying with the terms of research grants
Desire to dispel misconceptions about science
Expectation
Experience of public engagement.
For its own sake. To increase the accessibly of research.
For the interest of others.
Help secure additional funding
I am being paid for doing research, this is my job. My job is not to undertake any public engagement activity, but being paid for that would be motivating.
I believe it is a moral duty for publicly funded work.
I enjoy doing it. Occasionally opens up new ideas and connections.
I enjoy it
I enjoy it; talking to new audiences is a refreshing experience.
Influence changes in practice and increase awareness of hazards
Interest shown by public/non-academic individuals or organisations. It is very hard to motivate without a receptive audience.
it gives me a different perspective on the work that I do
It is a pleasure to organise these events - especially for younger people - curiosity and enthusiasm are always fun to see.
It is fun and rewarding in itself.
It's fun
It's fun!
Knowledge exchange, to get input i.e. to improve my research by taking into account views and needs of practitioners (and not only the other way around, i.e. my research having an impact on them).
Networking meeting new people and collaborators
Promote Engineering for Young females in Schools
Public well-being
Sharing knowledge; meeting new people; networking; travelling
The majority of my funding derives from charitable and public funded pots of money so morally I'm obliged to disseminate my work.
To challenge popular misconceptions perpetuated in the media.

to challenge public perception and broaden the parameters of the debate
to disseminate insights and improve the environment... to make a difference
To help the university and its profile
To increase the beneficiaries of the research and to make a difference.
To inform and influence the population directly, to make people understand the issues I research and change their behaviours towards better lifestyles.
To inform research and implementation
To innovate and be the first in the world.

The 35 responses in Table 4-41 show an array of motivators for taking part in public engagement, the most common being the *enjoyment factor* (20.0%). One respondent described public engagement as a 'refreshing experience', whilst another stated that s/he enjoyed seeing the 'curiosity and enthusiasm' exhibited by young people in particular, when working with them. The second most common motivator was the *influence* of one's research on a variety of things (16.1%). This ranged from general statements such as 'change the world' to more specific statements such as:

"To inform and influence the population directly, to make people understand the issues I research and change their behaviours towards better lifestyles."

Two other common motivators each constituted 10.7% of the thirty-five responses. The first pointed to academics themselves hoping to realise *benefits to their research* as a result of taking part in public engagement activities; this is in contrast to the 'influence' motivator stated above, which is more aligned to public groups, as opposed to academics benefiting from public engagement activities. One respondent for example, stated that taking part in public engagement activities gives him/her a "different perspective" on their work, whilst another stated that it allowed them to innovate and "be the first in the world" in the discovery of ideas or instruments. The second of the two motivators was *challenging misconceptions* about respondents' subject areas. One response for example, noted the role of the media in "perpetuating" such misconceptions, whilst another went further from not only challenging misconceptions but also "broaden the parameters of the debate".

4.4.6.5. Impact of public engagement activities

Respondents were asked the following question; *In the past five years, what impact has your involvement in public engagement activities had on the research that you do?* The responses are shown in Fig 4-72 below;

Fig 4-72: Q22. Impact of undertaking public engagement (n=205)

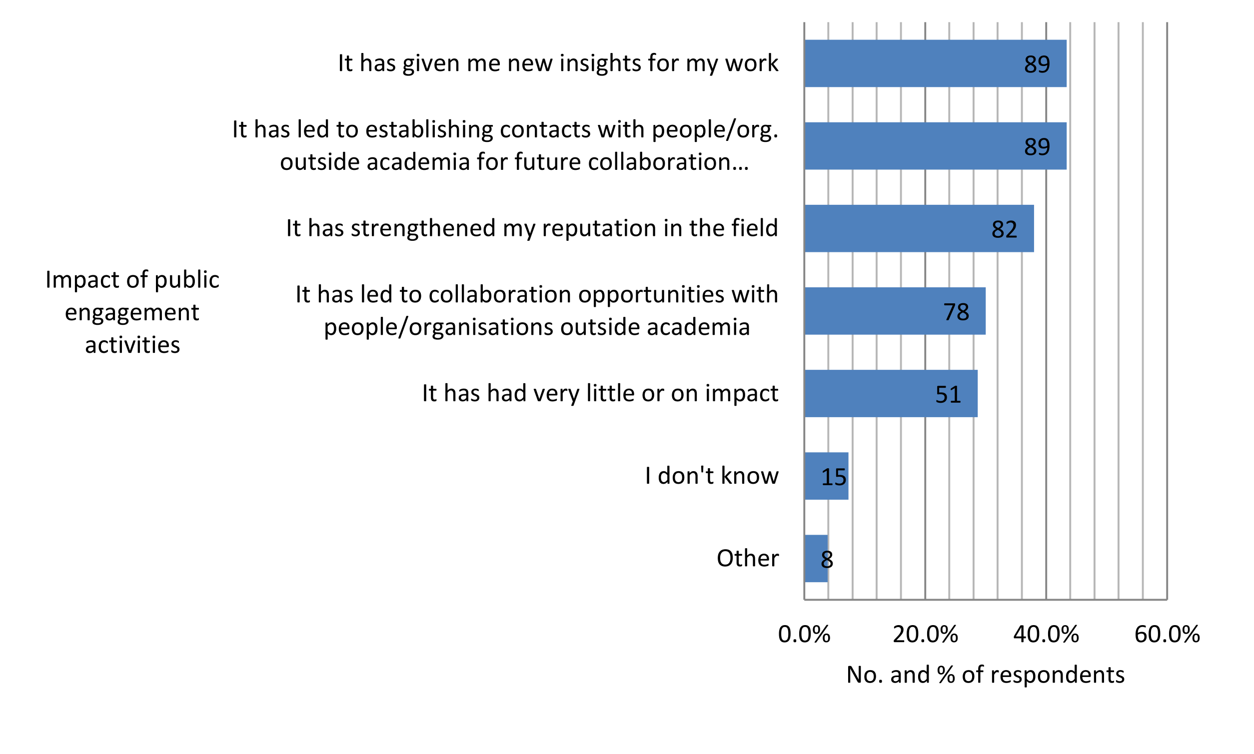


Fig 4-72 shows that, participating in public engagement activities not only gave researchers new insights to their work (43.4%), but also led to establishing contacts with people/organisations outside academia for future collaboration (43.4%). However, it can also be noted that almost a quarter (24.9%) of respondents stated that engaging the public with their research had had ‘very little or no impact’ on their research.

4.4.6.6. Relevant audiences for engaging with research

Questionnaire respondents were asked to state how important it was to engage with the following eleven audience groups; Policy Institutes, Political Parties, Charities, Local Government, Supranational Bodies, International Bodies, Schools, Industry, Government Departments, Professional Organisations, and the General Public. ANOVA tests showed main effects of the disciplinary groups on Schools, Industry and Professional Organisations. None of the tests showed interaction effects.

4.4.6.6.1. Disciplinary differences in relevance of Schools

The proportion of respondents from the Hard discipline group who viewed Schools as 'not important' (20.9%) was lower than that of both the Soft (36.6%) and Both Dimensions (34.2%) discipline groups. Moreover, it is respondents from the Hard discipline group who displayed the highest proportion (23.7%) of how 'extremely important' schools are as an audience, compared to respondents from the Soft (10.7%) and Both dimensions (7.9%) discipline groups.

Table 4-42: Q25. Hard v Soft - Schools

HARD v SOFT					
	Extremely Important	Very Important	Slightly Important	Not Important	Total
Hard	21 (23.1%)	22 (24.2%)	29 (31.9%)	19 (20.9%)	91 (100%)
Soft	14 (10.7%)	23 (17.6%)	46 (35.1%)	48 (36.6%)	131 (100%)
Both Dimensions	3 (7.9%)	9 (23.7%)	13 (34.2%)	13 (34.2%)	38 (100%)
Total	38 (14.6%)	54 (20.8%)	88 (33.8%)	80 (30.8%)	260 (100%)

There were no notable contrasts between the Pure v Applied disciplinary groups, however, as shown Table 4-43 below.

Table 4-43: Q25. Pure v Applied - Schools

PURE v APPLIED					
	Extremely Important	Very Important	Slightly Important	Not Important	Total
Pure	15 (16.7%)	22 (24.4%)	30 (33.3%)	23 (25.6%)	90 (100%)
Applied	17 (14.9%)	19 (16.7%)	35 (30.7%)	43 (37.7%)	114 (100%)
Both Dimensions	6 (10.7%)	13 (23.2%)	23 (41.1%)	14 (25.0%)	56 (100%)
Total	38 (14.6%)	54 (20.8%)	88 (33.8%)	80 (30.8%)	260 (100%)

An ANOVA test showed a main effect for the Hard v Soft disciplinary group $F(2,252) = 5.71$, $p<0.05$, such that Schools were viewed a more relevant audience for engaging with by respondents in Hard disciplines (M=2.51, SD=1.07) compared to Both Dimensions (M=2.95, SD=0.96) and Soft (M=2.98, SD=0.99) disciplines. There was a non-significant main effect for the Pure v Applied disciplinary group: $F(2, 252) = 2.78$, $p>0.05$, as well as a non-significant interaction effect between the Hard v Soft and Pure v Applied disciplinary dimensions: $F(3, 252) = 0.97$, $p>0.05$.

4.4.6.6.2. Disciplinary differences in relevance of Industry

As shown in Table 4-44, the proportion of respondents from the Both Dimensions group who viewed Industry as 'extremely important' (44.7%) was noticeably greater than both the Hard (28.6%) and Soft (16.8%) discipline groups. Moreover, the results show a greater proportion (30.5%) of respondents from the Soft discipline group who viewed the Industry audience as 'not important' compared to the Hard (17.6%) and Both dimensions (13.2%) discipline groups.

Table 4-44: Q25. Hard v Soft - Industry

HARD v SOFT					
	Extremely Important	Very Important	Slightly Important	Not Important	Total
Hard	26 (28.6%)	34 (37.4%)	15 (16.5%)	16 (17.5%)	91 (100%)
Soft	22 (18.8%)	35 (26.7%)	34 (26.0%)	40 (30.5%)	131 (100%)
Both Dimensions	17 (44.7%)	11 (28.9%)	5 (13.2%)	5 (13.2%)	38 (100%)
Total	65 (25.0%	80 (30.8%)	54 (20.8%)	61 (23.5%)	260 (100%)

Considering the Pure v Applied comparison; as shown in Table 4-45, the majority of respondents from both the Applied (63.2%) and Both dimensions (62.5%) discipline groups viewed Industry as either 'extremely important' or 'very important'. This can be contrasted with the majority of respondents in the Pure discipline group (57.8%) who viewed Industry as either 'slightly important' or 'not important'.

Table 4-45: Q25. Pure v Applied - Industry

PURE v APPLIED					
	Extremely Important	Very Important	Slightly Important	Not Important	Total
Pure	18 (20.0%)	20 (22.2%)	19 (21.1%)	33 (36.7%)	90 (100%)
Applied	28 (24.6%)	44 (38.6%)	26 (22.8%)	16 (14.0%)	114 (100%)
Both Dimensions	19 (33.9%)	16 (28.6%)	9 (16.1%)	12 (21.4%)	56 (100%)
Total	65 (25.0%)	80 (30.8%)	54 (20.8%)	61 (23.5%)	260 (100%)

An ANOVA test showed a main effect for the Hard v Soft disciplinary group $F(2,252) = 5.71$, $p<0.05$, such that Industry was viewed a more relevant audience for engaging with by respondents in Both Dimensions disciplines (M=1.95, SD=1.06) compared to Hard (M=2.23, SD=1.06) and Soft (M=2.70, SD=1.08) disciplines. There was a non-significant main effect for the Pure v Applied disciplinary group: $F(2, 252) = 2.10$, $p>0.05$, as well as a non-significant interaction effect between the Hard v Soft and Pure v Applied disciplinary dimensions: $F(3, 252) = 1.63$, $p>0.05$.

4.4.6.6.3. Disciplinary differences in relevance of Professional Organisations

Table 4-46 shows that a greater proportion of respondents from the Both Dimensions disciplinary group (42.1%) as opposed to Hard (29.7%) and Soft (20.6%) disciplines viewed Professional Organisations as an 'extremely important' audience for engaging with.

Table 4-46. Q25. Hard v Soft - Professional Organisations

	HARD v SOFT				Total
	Extremely important	Very important	Slightly important	Not important	
Hard	27 (29.7%)	34 (37.4%)	24 (26.4%)	6 (6.6%)	91 (100%)
Soft	27 (20.6%)	57 (43.5%)	31 (23.7%)	16 (12.2%)	131 (100%)
Both dimensions	16 (42.1%)	15 (39.5%)	6 (15.8%)	1 (2.6%)	38 (100%)
Total	70 (26.9%)	106 (40.8%)	61 (23.5%)	23 (8.8%)	260 (100%)

In relation to the Pure v Applied comparison, as shown by Table 4-47, respondents in the Pure disciplinary group (53.3%) were least likely to view Professional Organisations as either an 'extremely important' or 'very important' audience to engage with their research, compared to those in the Applied (73.7%) or Both Dimensions (78.6%) disciplinary groups

Table 4-47: Q25. Pure v Applied - Professional Organisations

	PURE v APPLIED				Total
	Extremely important	Very important	Slightly important	Not important	
Pure	17 (18.9%)	31 (34.4%)	25 (27.8%)	17 (18.9%)	90 (100%)
Applied	36 (31.6%)	48 (42.1%)	26 (22.8%)	4 (3.5%)	114 (100%)
Both dimensions	17 (30.4%)	27 (48.2%)	10 (17.9%)	2 (3.6%)	56 (100%)
Total	70 (26.9%)	106 (40.8%)	61 (23.5%)	23 (8.8%)	260 (100%)

An ANOVA test showed a non-significant main effect of the Hard v Soft disciplinary group $F(2, 252) = 2.70$, $p>0.05$ on Professional Organisations as a relevant audience for engaging with research. There was however a significant main effect for the Pure v Applied disciplinary group $F(2, 252) = 7.70$, $p<0.05$; respondents in Both Dimensions (M=1.95, SD=0.80) and Applied (M=1.98, SD=0.83) disciplines viewed Professional Organisations as a more relevant audience for engaging with their research compared to respondents in Pure disciplines (M=2.47, SD=1.01). There was a non-significant interaction effect $F(3, 252) = 0.79$, $p>0.05$ between the Hard v Soft and Pure v Applied disciplinary groups.

4.4.6.6.7. Summary of disciplinary differences in relevant audiences for engaging with

ANOVA tests have shown significant main effects for the Hard v Soft disciplinary group on the importance placed on Schools and Industry. *Schools* were viewed as a more relevant audience for engaging with by respondents in Hard disciplines compared to Both Dimensions and Soft disciplines. *Industry* was viewed a more relevant audience for engaging with by respondents in Both Dimensions disciplines compared to Hard and Soft disciplines. Pure v Applied main effects were only apparent for *Professional Organisations*; respondents in Both Dimensions and Applied disciplines viewed *Professional Organisations* as a more relevant audience for engaging with their research compared to respondents in Pure disciplines. The tests showed non-significant interaction effects between the Hard v Soft and Pure v Applied disciplinary groups for all the audiences above.

4.5. Summary of survey questionnaire results

The results in this chapter can be summarised into the following:

Collaboration

- Researchers in the Hard disciplinary group, as opposed to those in both the Soft and Both Dimensions groups were more likely to frequently collaborate with either researchers in their research group.
- The Pure v Applied group comparison were statistically non-significant.

Use of social media tools

- The majority of researchers (60%) were not making use of social media tools to raise awareness of their research, of those who did so, 40% used general social networking sites such as Twitter and Facebook whilst just over a quarter (27%) sites such as Mendeley mainly used within the academic community.

Open access to research outputs and research data

- Personal/group websites (34%) were the most common channel by which researchers were making their work open access, followed by institutional repositories (27%)
- The majority (62%) of respondents had not made their research data openly available anywhere on the internet over the past five years,
- There was no association between whether or not respondents had made their research data openly available over the past five years and how frequently they carried out research that required external funding.
- The most common type of research data made openly available was databases (38%), the least common being sound files (2%)
- The most common locations for uploading research data were the institutional repository (43%) and project website (41%); with less than a fifth of respondents (18%) uploading their data on open data repositories
- Of those who had made their research data openly available, the majority (59%) stated their making of research data openly available presented them with the opportunity for collaboration with researchers *within their discipline*, this can be compared with 30% who stated that it led to an opportunity to collaborate with researchers *outside their discipline*. Just over a quarter (27%) of respondents noted that sharing their research data had led to opportunities for collaborating with an external body such as a charity organisation or local government.

Public engagement

- 79% of respondents took part in public engagement; lack of opportunity and lack of time were stated as barriers, whilst increasing the impact of one's work was stated the most important motivator.
- More experienced researchers are more likely to take part in public engagement than less experienced researchers
- The most common activity of engaging with the public was 'presented to a professional audience' (73%), whilst the least common was 'made a public performance' (5%)
- The most highly rated motivators for taking part in public engagement activities was '*to increase the impact of my work'* and *'to inspire learning'*,

based on the proportion of who respondents stated that these were either 'extremely important' or 'very important', 72% and 69% respectively. This can be contrasted with only 38% of respondents who regarded *enhancing their career* as either extremely important or very important in motivating them to take part in public engagement activities.

- Whilst over a third of researchers (34%) stated that public engagement had had the impact of allowing researchers to gain more insights on their work, almost a quarter (23%) stated that it had had very little or no impact.
- There was no association between the disciplinary group to which one belonged, and whether or not they had undertaken any public engagement activity.
- Of the eleven groups of audiences considered, only three had statistically significant results; Industry, Professional Organisations and Schools:
- A greater proportion of respondents in both the Hard and Both Dimensions groups placed more importance on I*ndustry* as a relevant audience than those in the Soft disciplinary group. Likewise, a greater proportion of respondents in the Applied and Both Dimensions disciplinary groups placed more importance on Industry than those in the Pure disciplinary group.
- Respondents in both the Applied and Both Dimensions disciplinary groups were more likely than those in the Pure disciplinary group to view *Professional Organisations* as relevant audiences to engage with their research.
- A greater proportion of respondents in the Hard disciplinary group placed more importance on *Schools* as a relevant audience to engage their research with than those in the Soft and Both Dimensions disciplinary groups.

Chapter 5: INTERVIEWS

5.1. Introduction

This chapter reports on the other data collection tool used for this study – interviews. First it describes the pilot study undertaken and how the interviewees were recruited for the main study; it then provides a discussion on the strategy adopted for analysing the qualitative data before finally presenting the findings from the interviews.

5.2. Interview planning and administration

5.2.1. Pilot study

Pilot interviews were carried out on two academics; one in the arts and one in engineering, lasting 67 minutes and 48 minutes respectively. The purpose of the pilot study was to determine both the clarity and appropriateness of the questions; and also to get an idea of the length of the interviews. The two interviewees gave valuable feedback on one question which asked: “What do you understand by the term ‘academic freedom’?” which both interviewees felt that it was a leading question, considering the other questions in the interview on attitudes towards the socio-economic impact criterion used for evaluation for the REF2014. This question was then removed and the final interview schedule is shown in Appendix 2.

5.2.2. Recruiting interviewees

As stated in Chapter 4, the last question of the survey invited respondents to volunteer for participating in interviews. Of the forty-two survey participants who had initially volunteered, twenty participants confirmed through email, their willingness to be interviewed. An additional four interviewees were recruited by way of referrals from other academics so as to increase representation of respondents in the Hard/Pure and Interdisciplinary areas. This resulted in a total of twenty-four interviewees, who were asked to book their time slots using the *YouCanBookMe* booking software. Table 5-1 below shows the interviewees’ profiles.

Table 5-1: Profiles of the 24 interviewees

HARD PURE	**HARD APPLIED**
- HP1: Reader, 24-29 years, *Biological Sciences* - HP2: Lecturer, 6-11 years, *Physics* - HP3: Senior Lecturer, 12-17 years, *Computer Science & Informatics* - HP4: Reader, 30+years, *Computer Science & Informatics* - HP5: Professor, 30+ years, *Chemistry*	- HA1: Lecturer, 1-5 years, *Architecture, Built Environment & Planning* - HA2: Senior Research Fellow, 12-17 years, *Allied Health Professions* - HA3: Research Associate, 6-11 years, *Electrical and Electronic Engineering* - HA4: Research Associate, 30+ years, *Public Health Services* - HA5: Professor, 12-17 years, *Architecture, Built Environment & Planning*
SOFT PURE - SP1: Lecturer, 1-5 years, *Politics and International Studies* - SP2: Senior Lecturer, 18-23 years, *Politics and International Studies* - SP3: Senior Lecturer, Lincoln, 6-11 years, *History* - SP4: Professor, 12-17 years, *Politics and International Studies & Sociology* - SP5: Senior Lecturer, 12-17 years, *English Language and Literature & History*	**SOFT APPLIED** - SA1: Senior Research Fellow, 12-17 years, *Education* - SA2: Lecturer, 6-11 years, *Education* - SA3: Lecturer, 1-5 years, *Business and Management Studies* - SA4: Professor, 18-23 years, *Business and Management Studies* - SA5: Research Fellow, 24-29 years, *Art & Design: History, Practice & Theory* - SA6: Professor, 12-17 years, *Communication, Cultural & Media Studies Library & Information Management*
INTERDISCIPLINARY - INT1: Senior Lecturer, 18-23 years, *Clinical Medicine + Computer Science & Informatics* **[Hard Interdisciplinary]** - INT2: Lecturer, 6-11 years, *General Engineering + Education* **[Applied Interdisciplinary]** - INT3: Research Fellow, 1-5 years, *Public Health Services + Sociology* [**Interdisciplinary interdisciplinary** (i.e. no dominant axis)]	

5.2.3. Ethics

Attached to the email sent to interviewees were two documents: the participation information sheet and an informed consent form. These documents provided more information about the study; including ethical clearance from the researcher's university, permission to audio-record the interview, interviewees' right to withdraw from the study at any time, and assurances of confidentiality – specifically that, neither interviewees names, nor the names of the department/school and university to which they belonged would be published. The above key points were also reiterated verbally to each interviewee before the start of each interview and all interviewees gave consent for the interview to be audio-recorded - a digital voice recorder was used for this. Both the interviewee and the researcher retained signed copies of the informed consent forms. The majority (18) of the interviews were done face-to-face, in interviewees' offices, whilst five were done on Skype and one was a done over the telephone.

5.3. Interview data analysis strategy

This section describes the approach of qualitative data analysis adopted for this research project. Following that, the chosen coding methods are specified and the coding strategy is illustrated. *NViVo* data analysis software was used for coding of interview data in this study.

5.3.1. Qualitative data analysis approach

Thematic analysis was used as the overarching approach for analysing the interview data. Thematic analysis is: "a method for identifying, analysing, and reporting patterns (themes) within data." (Braun & Clarke, 2006, p.73). A theme is a pattern found in the data, which at minimum describes and organises the possible observations, and at a maximum interprets aspects of the phenomenon. Themes can be generated inductively from the raw interview data, or generated from theory and prior research (Boyatzis, 1988, p.4). As explained in section 3.3, this study adopts an inductive approach.

Braun & Clarke (2006) divide how thematic analysis has been used by various scholars into two classes. The first class depicts research that has been tied to, or stemming from a particular theoretical or epistemological position such as

Grounded Theory. The second class depicts researchers that have used methods that are essentially independent of theory and epistemology, and can be applied *across* a range of theoretical and epistemological approaches. Braun & Clarke (2006, p.77) state that this “theoretical freedom” depicted by the second class makes thematic analysis a flexible approach, which can potentially provide a rich and detailed, yet complex account of data. Braun & Clarke’s (2006) idea of inclusion of epistemological and theoretical perspectives in the first class bring to light the distinction they sought to make between thematic analysis and Grounded Theory.

Grounded Theory, originally developed by Strauss & Corbin (1967) is based on the development of a theory through the analysis of data. The difficulties in identifying firm boundaries between Grounded Theory and thematic analysis have been acknowledged by Denscombe (2003), Braun & Clarke (2006) and Bryman (2012). Braun & Clarke (2006, p.77) in particular, argue that Grounded Theory, together with other approaches to qualitative data analysis such as narrative analysis overlap more or less with thematic analysis, as they are all related with “analysing themes”. Braun & Clarke (2006, p.77) use a phrase Grounded Theory “lite” (as opposed to Strauss & Glasser’s (1967) “full” Grounded Theory) to describe a set of procedures for coding data very much akin to thematic analysis. The “full” or original Grounded Theory (Strauss & Glaser, 1967) was rejected for this project as its end-goal is to generate a theory through its encouragement of non-referral to prior knowledge of the topic i.e. not undertaking a literature review (Bryman, 2012, p.574); the researcher already had undertaken a literature review to explore the topic and identify gaps.

5.3.2. Coding methods

The key process to analysing data is through coding it; a code, as defined by Saldana (2009, p.3) is a “word or phrase that symbolically assigns a summative, salient, essence-capturing and/or evocative attribute for a portion of interview transcripts ...” In *The handbook of coding,* Saldana (2009) identifies thirty coding methods that can be used for data analysis, only four, which are relevant for the purposes of this project are discussed below; these are divided into first cycle and second cycle coding methods. First cycle coding methods are employed after reading the data and splitting it into individually coded segments, whereas second cycle methods are applied at the latter stages of data analysis and involve constantly comparing and re-organising data and also developing new codes.

Examples of first cycle coding methods include in vivo coding and structural coding. *Structural coding* entails applying a conceptual word or phrase representing a topic of enquiry to a particular segment of the data and can be applicable in exploratory semi-structured data gathering techniques with multiple participants (as was the case for this project). This can be contrasted with *in vivo coding* where the researcher uses the words of respondents to formulate codes. Structural coding was selected as a more suitable method in the first cycle of the coding process as it allowed the researcher to initially identify the different attitudes and research practices of the twenty-four interviewees. Appendix 3 shows an NVivo screenshot of the parent and child nodes that emerged from this.

The explanation in section 5.3.3 below however will reveal that *in vivo* coding was not completely disregarded but also incorporated during the development of memos, which are a crucial tool in the coding process. Examples of second cycle coding methods on the other hand, include elaborative coding and pattern coding. *Elaborative coding* involves analysing textual data in order to develop theory further; this makes it suitable for qualitative studies that build on previous qualitative research to either confirm of disconfirm the findings (Saldana, 2009, p.168). *Pattern coding* on the other hand, involves using codes that are explanatory or inferential, leading to the formation of theoretical constructs or processes (Saldana, 2009, p.153). The latter method is more suitable for this project as (i) it is focused on identifying patterns in different disciplinary groups in academics' research dissemination behaviour and their perception of the term 'research impact' (ii) elaborative coding is based on comparing the emerging themes with the findings of a previous research project which was not the aim of this project.

5.3.3. Incorporation of memos

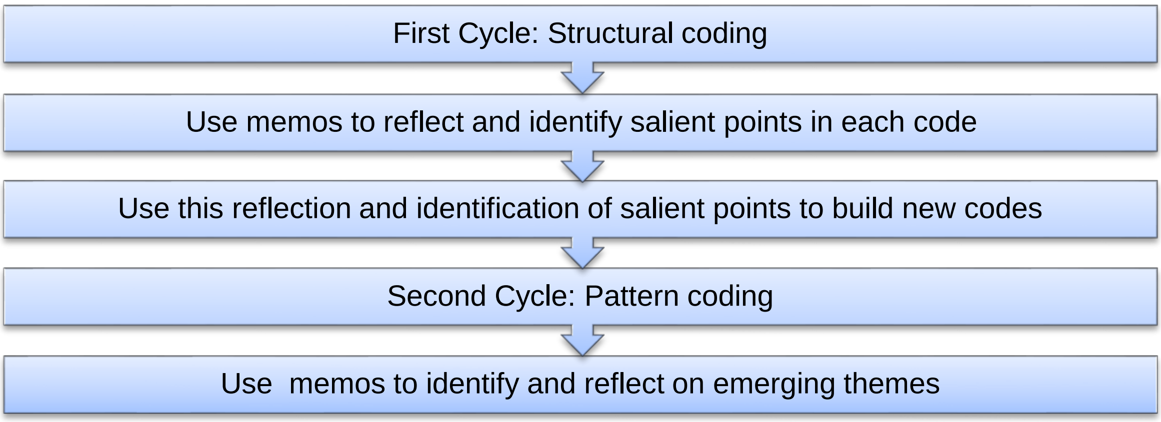
In conjunction with coding, *memos* were used to document and reflect on the coding process, how the process of inquiry is taking shape and the emergent patterns (Braun & Clarke, 2006, p.77). After constructing the codes based on the themes of the interview questions (*structural coding*), the researcher then searched for salient point(s) in each of the interviewees' responses, that had been assigned to their respective codes. Memos were then used to record these salient points, which were in the form of the interviewer's interpretation of the interviewees' responses and/or direct language used by the interviewee (*in vivo*). Table 5-2 below illustrates factors that were considered to achieve this.

Table 5-2: Factors considered during the coding and memoing process (Bernard & Ryan (2010, pp. 56-63

What to look for in the data	Explanation
Repetitions	repeated references by the interviewee to a particular aspect
Indigenous Typologies:	particular 'local' words, for example, the language used in different disciplines
Metaphors and Analogies:	these may be used by interviewees to convey their thoughts, experiences or behaviours
Transitions:	pauses, changes in the tone of voice or the presence of particular phrases
Similarities and Differences:	involves searching for similarities and differences by making systematic comparisons across units of data. Degrees of strength in themes may lead to the naming of sub-theme
Linguistic Connectors:	these are words and phrases that indicate attributes and various kinds of causal or conditional relations
Missing Data:	instead of approaching the data with the question: "what is here?" using the "what is missing?" approach
Theory-Related Material:	involves examining interviewees' ways of thinking about processes, activities or events based on theory. This technique however, has the pitfall of the researcher only finding what they are looking for.

The next phase was to examine the salient points from the memos and use them to develop new codes, from which *pattern coding* was carried out, with the aim of identifying emerging themes. The following process diagram illustrates the coding and memoing process for this:

Fig 5-1: The coding and memoing process adopted for analysing interview data



The process diagram above emphasises the importance of memos in identifying the salient points emerging from the data and also reflecting on them. The interview data generated 89 pages of memos; an example memo of attitudes towards public engagement from one of the interviewees is shown in Fig 5-3 below;

Fig 5-2: Sample memo on attitudes towards public engagement

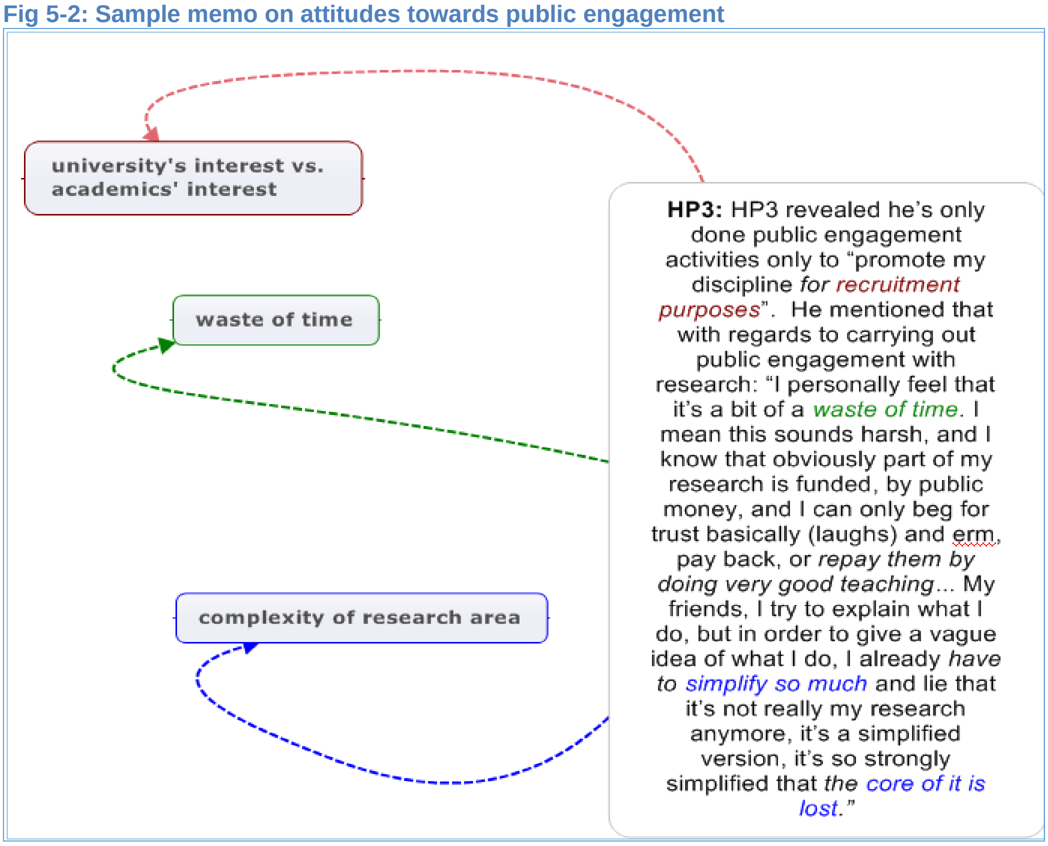


Fig 5-3 shows the salient points in the memo highlighted in coloured italicised text, with the resultant themes shown in the three rectangular boxes.

As stated above, the analysis involved structural and pattern coding techniques to identify whether there were recurring themes within the interview dataset and whether the themes were similar or different within disciplinary groups – thereby allowing disciplinary group comparisons to be made. Thus, the analysis used standard qualitative data analysis techniques, although in reporting the results of the analysis a quantitative indication of the number of respondents from each disciplinary group was used as a signifier of the importance of the pattern. Using quantitative signifiers when reporting the results of qualitative analysis could perhaps be considered a limitation, but the narrative is grounded in the systematic qualitative analysis of the experiences of interviewees and the structural coding, in conjunction with the use of memos, allowed for unexpected themes to be identified.

The next sections present the findings from the interview. The sections are structured in the following way; firstly, section 5.4 looks at the collaborative activities of interviewees, this is an introductory section that highlights a number of issues which are then explored at greater depth in the successive sections. Secondly sections 5.5 to 5.9 look at academic attitudes and dissemination practices of research outputs, including, specifically research data. Finally, section 5.10 reports on interviewees' perception of 'research impact' and their awareness of how the socio-economic impact might be measured.

As highlighted in Chapter 4, the unit of analyses adopted for this research project is based on the two dimensions of Hard disciplines compared with Soft disciplines, and Pure disciplines compared with Applied disciplines, and the Interdisciplinary group. The interview data have been presented according to these dimensions. *Mindjet* mind-mapping software is used to graphically present the findings, followed by the narrative.

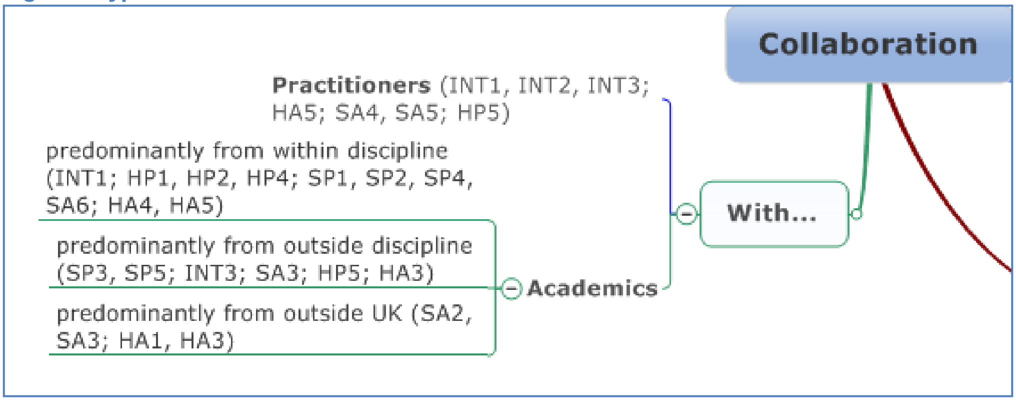
5.4. Collaborative activities

Questions on collaboration sought to uncover which groups interviewees predominantly collaborated with, what facilitates such collaboration and also, the realised benefits of being involved in collaborative activities. These issues are addressed below in the following three sub-sections:

5.4.1. Types of collaborators

The interviews revealed various types of collaborators that interviewees in the different disciplinary groups collaborate with. Fig 5-4 below, together with Figs 5-5 and 5-6 are components of a single diagram on the findings of collaborative activities that has been exploded to illustrate the relevant issues in sub-sections 5.4.1, 5.4.2 and 5.4.3.

Fig 5-3: Types of collaborators



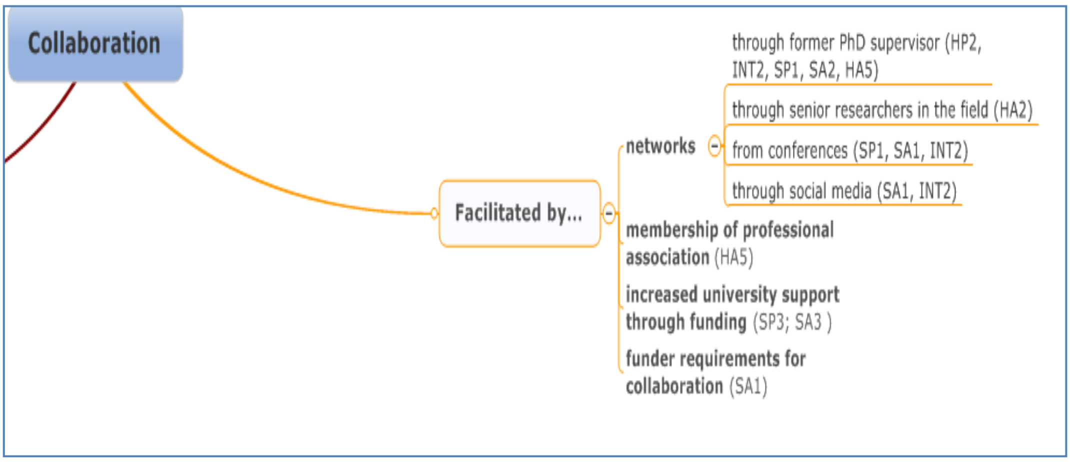
All interviewees stated having been involved in collaborative activities with different groups of collaborators. There seems to be a pattern of interviewees from mostly Pure disciplines (compared to Applied disciplines), collaborating with academics within their parent discipline for example; SP4 (politics and international studies & sociology), HP1 (biological sciences) and HP2 (physics) all predominantly collaborated with academics within their discipline. One interviewee for example, HP2 (physics), described his research community, (most of whom were from his parent discipline) as small and “tight knit” hence why he was most likely to collaborate with researchers in his parent discipline. Another interviewee, SP1 (politics and international studies) explained that his collaboration network had been built with the aid of his former PhD supervisor with whom he has maintained contact, years after completing his PhD. The former PhD supervisor’s extensive networks have influenced the type of academics SP1 collaborates with, most of whom are predominantly within his parent discipline.

There was, however, a small number of academics from Applied disciplines compared to Pure disciplines who also predominantly collaborated with researchers within their discipline. For example SA6 (culture and media studies) stated that he had experienced “problems of different methodological orientations” when collaborating with those outside his discipline, hence he preferred to mostly collaborate with those within his discipline. There seemed to be no apparent disciplinary differences for those predominantly collaborating with academics from outside their parent discipline, although a closer look at the specific quadrants (hard/pure, soft/pure, hard/applied/ soft/applied) in Fig 5-4 shows 2 out of 6 academics who collaborated outside their parent discipline were from the soft/pure quadrant.

Researchers in Applied research disciplines (for example; education, business management, electrical engineering etc.) reported collaborating with practitioners more often than researchers in Pure research disciplines, as might be expected. In addition, the three interviewees (INT1, INT3 and INT2) who were classified as interdisciplinary due to the fact that their research disciplines straddled both dimensions of hard-soft or pure-applied described their collaborators as being predominantly practitioners. In terms of collaborating outside the UK, researchers in Applied disciplines were more likely to be engaged in international collaboration. There were, however, no apparent differences when comparing the Hard and Soft dimensions in the case of collaborating either with practitioners or international academics.

5.4.2. Facilitators of collaboration

Fig 5-4: Facilitators of collaboration



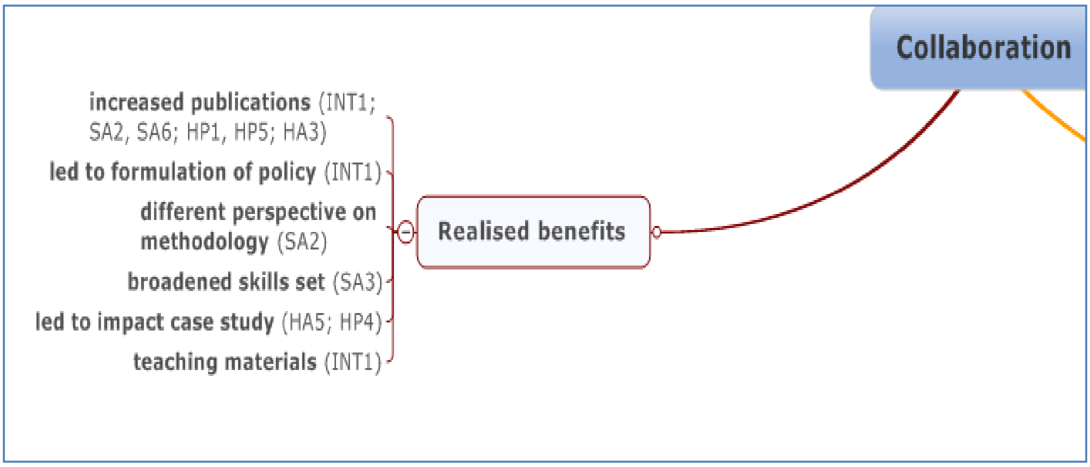
There was evidence from some interviewees that their PhD supervisors had helped in cultivating links/networks with other academic collaborators. This was reported by even those academics that had been doing research many years after their PhD. There were, however, no disciplinary differences here. In addition, one interviewee, HA5 (architecture, built environment and planning) gave an example of how one of his collaborations had been facilitated by his membership of a professional association in which he is part of a special interest group which allowed him to collaborate with academics in various fields of his discipline. It also seemed, that conferences and social media play a role in facilitating collaborations, particularly for those in the Applied disciplines, more discussion on conferences can be found in section 5.5 whilst that of social media can be found in section 5.8 of this chapter.

Collaboration, it seems has increasingly become more important even to those who reported that they had in the past mainly done their research individually. SP3, for example, a history academic explained she had been approached by two international scholars to work on an EU-funded project, and suggested that this may have been because she had *"become more senior"* as this is something that would not have happened in the past. Another reason for these collaborative opportunities was that there had been increased support for collaboration by her university so as to increase the chances of attracting external funding that would otherwise be difficult to attract if it were applied for individually.

Another interviewee SP5 (history and English literature) explained that she had recently started moving from individual research which she described as *"moving out from that lonesome slot"* and gave examples of three projects she hoped would be "a little more impactful". SP5 was in discussions with different groups of potential collaborators - from academics in the same discipline to librarians, however, she was keen to emphasise that in the humanities, collaboration was not widely carried out "*because you develop your own field*" from the "*wide swathe*" of literature, hence the reason for her perception that "*REF collaborations aren't as highly regarded, as individual pieces of work*." The two phrases above: "moving out of that lonesome slot" and "little more impactful" indicate SP5's desire for her research to make an impact beyond the academic community – on public libraries for example, although due to the nature of research in the humanities, she acknowledges that the underpinning research outputs such as journal articles, produced through collaboration are not highly regarded for the REF.

5.4.3. Realised benefits from collaboration

Fig 5-5: Realised benefits from collaboration



A number of interviewees were able to state the benefits they had realised as a result of collaboration. Such benefits include those realised within the academic community and those outside of it. With regards to the benefits within the academic community, a quarter of the interviewees stated that it had directly led to an increase in publications. One of the interviewees (SA3, business and management studies) however, explained that although she had on the whole benefited from increased publications as a result of collaboration, one of her collaborations involving an education academic presented problems in finding a suitable journal that accommodated both of their disciplines.

Other benefits realised by interviewees include personal development such as a "broadening of skills set" (SA3 – business and management studies) and acquiring a different perspective on methodology (SA2 – education) – this contrasts with SA6 (media and cultural studies) above who stated having encountered problems with academics having different methodological orientations.

With regards to benefits outside the academic community, two interviewees in the Hard disciplines – engineering and computer science, stated that collaboration with practitioners directly led to an impact case study which was subsequently submitted for the REF2014. Another interviewee (INT1, clinical medicine & computer science) stated how one of his collaborations had specifically led to the development of teaching materials and formulation of policy by publishing a paper in a practitioner journal which was then used by a local hospital for formulation of policy on best practices on eye care.

5.4.4. Summary on collaborative activities

The interviews revealed different types of collaborative activities that were being carried out by academics. It transpired that it was those interviewees from mostly Pure disciplines who were predominantly collaborating with academics *within their parent discipline*, whilst those from mostly Applied disciplines were collaborating with academics predominantly *from outside the UK*. Moreover, it seems academics from mostly Applied and Interdisciplinary compared to Pure disciplines were collaborating with *practitioners*. There seemed to be no apparent differences when comparing Hard and Soft disciplines in this regard.

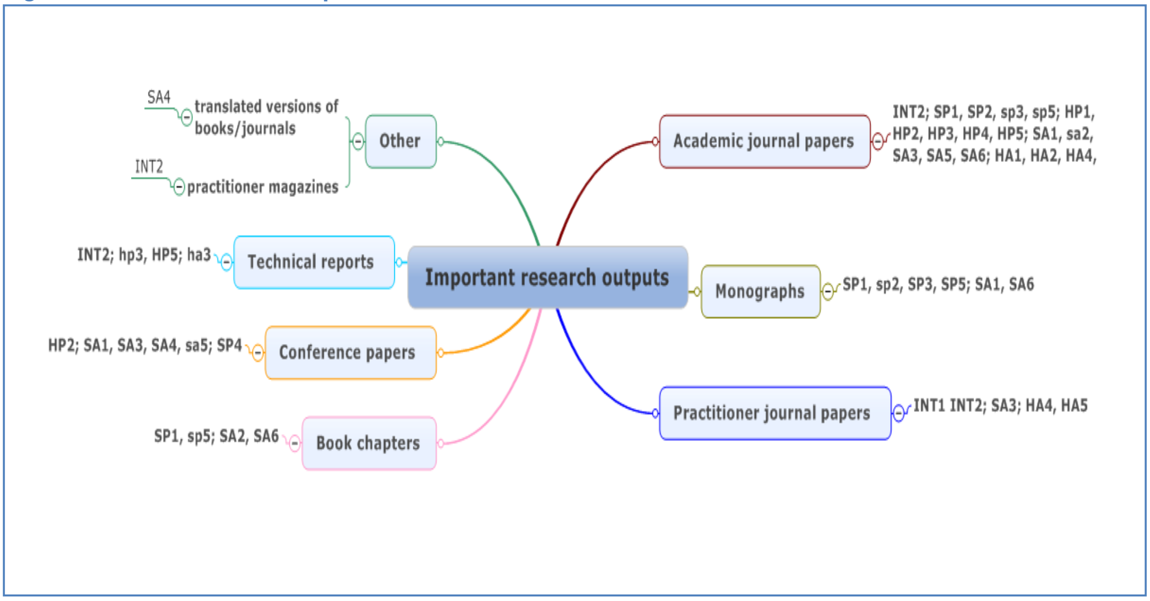
Some interviewees reported having realised benefits to their research as a result of collaboration; such benefits range from those focused within the academic community such as 'increased publications' to those beyond the academic community such as 'led to formulation of policy' and 'led to impact case study'. While there were no disciplinary differences in the benefits within the academic community; when it came to beyond the academic community it was those interviewees from Applied and Interdisciplinary disciplines as opposed to Pure disciplines who had realised such benefits. There were no differences when comparing Hard with Soft disciplines however.

5.5. Valued research outputs

Asking interviewees what research outputs they valued the most gave some insight into the influence a university or academic department has on academics' research dissemination behaviour. As illustrated in Fig 5-7 below, most interviewees revealed that academic journal papers were important to them;

although, as expected, they were less valued by those in soft/pure disciplines, for example SP3 (history) and SP5 (English literature and history) who valued monographs the most.

Fig 5-6: Valued research outputs



NB: lower case denote outputs that were viewed as less important by an interviewee

Phrases referring to the academic journal paper as “the real research output” (HA5, architecture, built environment and planning) and “the mainstay” (SP2, politics and international studies) were used by some researchers to reflect how important publishing a journal article was to them. As briefly stated above, researchers in the Soft disciplines such as history and English literature viewed journal articles as less important compared to monographs. Although journal articles are less important than monographs as stated by SP5 (English literature and History) – *“in terms of priority for the REF”* they were, however, valued by researchers more than other outputs such as book chapters. With regards to the book chapters, SP5 explained how, although most of her work had been produced individually, she had found book chapters very useful for publishing collaborative work through meeting at symposia with other contributors to an edited collection. Another interviewee, SA6 (media and cultural studies) concurred that with book chapters, although important, “*you’re not going to get any credit for it*”. SP5 and SA6 point to the issue of academic autonomy which is discussed in detail in section 5.5.1 below:

Other research outputs such as conference papers were viewed as important by some interviewees, particularly from Soft disciplines (soft/applied particularly) compared to the Hard disciplines. When it came to the pure-applied comparison, as shown in Fig 5-7, fewer interviewees from Pure disciplines, compared to Applied disciplines viewed conference papers as important. This exposed the differences in preferences by interviewees between *presenting at conferences* and having their work *published in conference proceedings*. HP2 (Physics) for example, stated how presenting at a conference was more important than getting a paper published in the conference proceedings which were less prestigious than academic journals, which were seen as the ultimate outlet where conference presentations would be published. However, some interviewees revealed their dislike for attending conferences altogether. One of them, SP2 (politics and international studies) attributed this to "conference politics" and described conferences as "facilitating very little exchange and favouring monologue". In addition, HP3 (computer science) questioned the "expertise" of some of the conferences he had been to. Despite most comments relating to the (lack of) importance of conferences coming from interviewees from Pure disciplines, SA6 (media and cultural studies) also described the "pantomime of questions" at conferences as not necessarily helpful.

5.5.1. Attitudes towards academic autonomy

There was compelling evidence from some interviewees, particularly in Applied disciplines, compared to Pure disciplines, who felt they were being steered by their academic department/school to choose which type of research output to produce. It transpired that in most cases the source of this steering was the department/school's preparation for research evaluation mechanisms such as the REF.

Some interviewee responses pointed to how academics felt 'pressured' to publish in particular academic journals - SA3 for example, a business and management studies academic revealed how they were expected in their school to publish their work in the highly rated journals on the Association of Business Schools (ABS) journal list:

"…my School pays a lot of attention to that list, and they very much want us to publish in the journals that are very highly ranked on that list because when the School submits for funding through the REF, having more publications in highly ranked journals tends to help the School do better in REF type situations… the set of journals that the School says are the best to publish in for REF purposes, often excludes the kinds of journals that managers might read, the professional kinds of journals, those are ranked lower, and so much less incentive to publish in those." (SA3, business and management studies)

SA3's quote above highlights a tension issue with regards to institutional steering towards publishing for submission to the REF; while SA3 wishes to target non-academic audiences through publishing in professional journals there is little incentive to do so because of her school's orientation towards the REF - hence the pressure to publish in highly rated academic journals on the ABS list. Another interviewee from the same discipline at a different university gave a contrasting opinion with regards to the ABS list however. SA4 stated that:

"…my university is slightly unusual because - and it's one of the reasons why I like my university because it's a little bit more relaxed about the ABS list than some universities..." (SA4, business and management studies)

There are various reasons that could explain the different approaches by both SA3's and SA4's universities; one of them could possibly be attributed to the universities' standing in terms of their prestige in research i.e. whilst SA3's university is a research-intensive university, as identified by its membership of the Russell Group of universities, SA4's is not.

SA4 added that her university was also more "relaxed" about producing monographs and submitting them for the REF, as they did for one of her monographs; this "surprised" her as her previous university – a research intensive one – would not have accepted it. In a departure from how positively she viewed her university's research dissemination policies, SA4 revealed that while she valued publishing in other languages such as French and Polish which allowed more potential readers access to her work, *"management doesn't necessarily* *regard it as important"*. SA4 explained however that she was quite "pragmatic" about such policies as the university is ultimately her employer and has a "right to guide" what and where she publishes.

Some interviewees were keen to have their work widely read regardless of the reputation of the journal. HA5 (education) for example, stated how the pressure of publishing in highly-rated journals, some of which were not openly accessible potentially limited the readership of his work. He added:

> "For me, I want as many people to read my stuff as much as possible because that's important for me, for my self-esteem... But of course because of my boss, my funding body and my long-term careers prospects, you've actually got to be in the high valued researcher journals." (HA5, Education)

HA5 reveals here that the main motivator for publishing his work is more people having access to it, as opposed to focusing on publishing on highly-rated journals, which are important for his long-term career prospects and encouraged by his manager.

Two interviewees, INT1 (clinical medicine and computer science) and HA3 (electrical and electronic engineering) characterised publishing in journals as something that is done by 'ambitious people'. HA3, for example, an electrical engineer stated that he was *"possibly not the most ambitious person*" therefore he was more concerned with the outcomes of the research rather than the output used to communicate the research. The two were keen to differentiate themselves with colleagues in their schools who they described as eager to publish a lot of journal papers for career advancement purposes. INT1 stated that his work was not submitted for the last REF, because he had not met the criteria, he added:

> "... I'm not ambitious. The ambitious people who want professorships by a certain time, I'm afraid they are driven, and a way to get brownie points at this university is to follow REF absolutely... though I'm publishing, I'm not publishing in journals of high impact*."*

Other interviewees, for example INT2 (electronic and electrical engineering & education) painted an interesting picture on what research outputs are important to her, important for the REF as well as industry:

> "So from a REF point of view, journal papers are important, from industry point of view, they are less important, industry sees less importance in that. From a personal point of view, it can vary, and it depends on what we're doing at the time, sometimes, other outlets, so we'll vary our outlets to practitioner magazines, practitioner journals, especially if we're looking for collaboration in a different area, because not all our collaborators will look to journals for the work that they do..." (INT2, electrical and electronic engineering and education)

INT2 points to how the prospect of collaboration with practitioners shapes how she values non-academic outputs, although she still acknowledges how journal papers are important for the purposes of research evaluation.

5.5.2. Summary on valued research outputs

A variety of types of research outputs were noted as important by researchers. Monographs, conference papers and book chapters were noted as important by mostly those from Soft disciplines, whilst technical reports were valued by those from Hard disciplines. On the other hand, practitioner journal papers/magazines, translated books/journals were valued by those mostly from Applied and Interdisciplinary disciplines. There were no consistent disciplinary patterns for the academic journal as it was represented in all groups.

The interviews also revealed some evidence of disciplinary differences with regards to attitudes towards academic freedom; whereby it was mostly those from Applied disciplines who felt constrained by policies and a continual focus on REF results when deciding what research output to produce and where to publish it. One of the reasons of such constraint was interviewees valuing other non-academic outputs such as practitioner journals/magazines and translated works more than the journal articles they were expected to produce.

Although respondents from the Soft disciplines in general were more positive towards conferences, with regards to comparing disciplinary groups, there was some evidence that it was the interviewees in the soft/applied quadrant particularly, who viewed conference papers as important research outputs.

5.6. Dissemination of research data

One of the objectives of the research project is to establish whether research data sharing or using of openly available data has made an impact on academics' research activities. First interviewees were asked to state types of data they typically produced, and the responses are illustrated in Fig 5-8 below:

Fig 5-7: Typically produced data types by disciplinary group

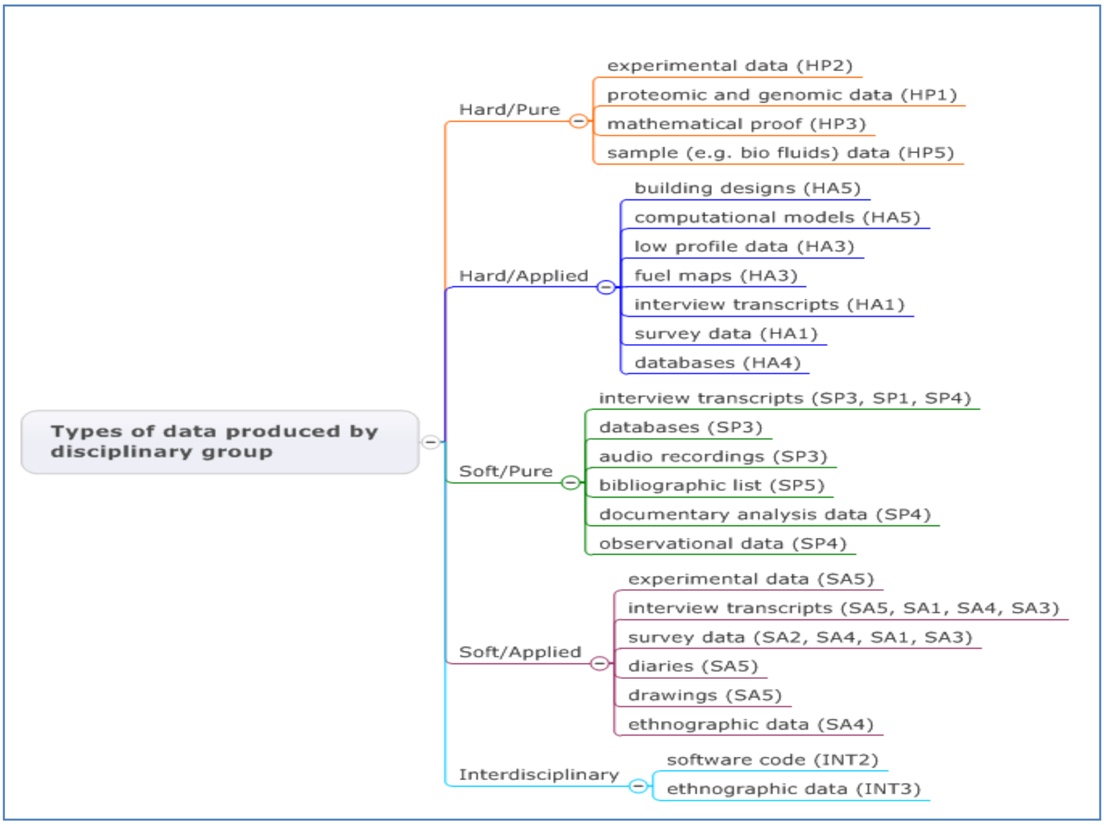


Fig 5-8 shows that the interviewees produced an array of data; the most common types of data were interview transcripts and survey data, produced predominantly by those from the Soft disciplines. Some types of data, straddled both Hard and Soft disciplines, for example, experimental data, which was produced by HP2 (physics) and SA5 (design).

5.6.1. Describing 'research data'

The interviewer was conscious that the phrase 'research data' can be interpreted differently by academics in different disciplines and it became clear from some of the responses of academics in the hard/pure and soft/pure disciplines; for example, HP3, a theoretical computer scientist who stated that the phrase 'research data' is not used in his research area, rather the phrase 'mathematical proof':

"...we state theorems, truths into that model and then we justify the correctness of that theorem and give a mathematical proof. So in a sense, all that data needs to be, it's the proof, it's the same as data, and it must be there, if it's not there, then it's not research..." (HP3, computer science)

"Actually if you talk about data, it's not a term that we use in the humanities because it's not, we kind of think about that as number-crunching." (SP5, English literature and history)

SP5 then showed the interviewer a book she had produced that had a list of bibliographies of poems, short stories, and serialised fiction dating back to the beginning of the 21st century, and she described that as research data. In comparison, another humanities interviewee, SP3 (a historian) did not seem to have the same issue with defining what research data was; to her, research data were the audio recordings, databases and interview transcripts she typically produced.

5.6.2. Sharing/ using openly available data

When it came to discussing the issues relating to sharing openly available data, some interviewees did not seem interested or keen to do so. For example, HA2 (allied health professions) stated before the interview started that she would not be of any use in answering the section of the interview about research data. Most interviewees across all disciplinary groups however, engaged with the interviewee with varying levels of enthusiasm, but those, particularly from Interdisciplinary and Soft (as opposed to Hard) disciplines were keen to point out that with regards to sharing research data, confidentiality was a prime barrier.

INT2 (electronic and electrical engineering & education) for example, whose work involves working with industrial partners stated that due to intellectual property issues, the data had to be stored in secure repositories. One interviewee, INT3 (public health and sociology), explained the problems she had encountered with a research funder who had required her to make her data openly available. INT3 stated that one of her projects fell under the NHS research governance framework which has a portfolio of studies most of which are in the public domain, but because she had guaranteed the local authority which had allowed her to collect data that it would not be published she declined to make it openly available, to which the NHS ultimately agreed. Other interviewees: SA1 (education), SA5 (design) and SA2 (education), SP1 (politics and international studies) and SA4 (business and management studies emphasised that even if efforts were made to anonymise the data, readers could still potentially be able to deduce the interview subjects. SP1 for example, explained that:

"…the area I do research in can be quite difficult to openly share that because obviously terrorism and radicalisation is quite a sensitive subject. So a lot of the data it has to be anonymised before I can publish it, so I haven't actually made any of my research data openly available, but that's partly down to how I did the interviews and the protections I gave the interviewees which range from very senior people to politicians and to get them to be open about the things they were telling me, it was really important to say 'this won't be published'". (SP1, politics and international studies)

SA4 also described the nature of her interviews. She stated that the people she interviewed were:

"…very specific individuals who are being interviewed in their specific role... and so I've always argued successfully within our ethics system that it would be in practice very hard to anonymise that data, very hard or nearly impossible". (SA4, business and management studies)

She said however, when it came to sharing quantitative data such as survey results it depended on the unit of analysis, provided the unit of analysis could be anonymised then she would be willing to make the research data openly available.

5.6.3. Benefits from sharing/use of openly available data

An interesting development with regards to open data sharing/use was that while none of the interviewees stated *sharing* data openly had had an impact on their research activities, some had realised various benefits from *using* openly available data. HA5, for example, explained how using openly available data allowed him to co-author with the data creator;

> "...what I normally do in those situations is I will say to the author; 'I'd be keen to collaborate with you and at the very minimum, anything we publish based on this, you will be acknowledged, but, how about we co-author a paper on this?' And I've done that before now, so we've contacted a person who had some physical data, some experimental data that we needed for validation and I said; "let's write a paper on this" and we've done, we've published it and they were co-author with me, so it worked really well." (HA5, Architecture, built environment and planning)

In addition, another academic (SA3, business and management studies) explained how she was in the process of trying to set up a potential collaboration with the creator of a dataset. Others such as SP1 stated using an openly available dataset allowed him to make generalisations from the qualitative data he had.

5.6.4. Summary on dissemination of research data

Interviewees reported having produced an array of types of research data; the most common being interview transcripts and survey data, which was produced predominantly by those from Soft disciplines. Some types of data straddled both Hard and Soft disciplines, for example, experimental data, which was produced by HP2 (physics) and SA5 (art and design).

Some academics were able to explain that they had realised benefits such as publishing more research as a result of *using* openly available research data. There was however no evidence of that with regards to *sharing* their own data. It seems confidentiality was a primary barrier of not sharing data, whereas when it came to using openly available research data, 'technological issues' and 'poorly documented data' were among the barriers stated by academics, particularly those in Hard disciplines.

5.7. OA publishing - attitudes and practices

In light of the HEFCE's (2013) policy on requirements for all REF 2020-submitted journal articles and conference proceedings to be uploaded on institutional repositories (IRs), the interviewer sought to uncover researchers' awareness and attitudes towards of OA practices.

5.7.1. Attitudes towards OA

When asked if they were aware of the existence of any policy by their university, either encouraging or requiring them to upload their research outputs on the institutional repository, some researchers, for example INT1 (clinical medicine and computer science), SA4 (business and management studies) and SA2 (education) stated that they were aware of it:

> "My university is incredibly pro-active, so even guys like me, who prefer to sit in a little room to get on with it, they sort of drag us kicking and screaming and say; 'Put stuff in there!' (INT1, clinical medicine and computer science)

The researcher probed INT1 to state how he felt about being required to upload his papers on the IR and he responded that he was supportive of such a policy because *"the taxpayer was paying for it after all*". Another academic, SA4 (business and management studies) spoke of how positively she viewed her university's "*philosophy*" of OA and stated that this was one of the reasons that attracted her to join the institution. Furthermore, SA2 (education) talked about the "*moral obligation*" to make research as openly accessible as possible.

Some interviewees however, were either unsure of what OA entails or were merely disinterested in the matter. SP5 (history and English literature), for example stated that she had only learnt recently about specific OA issues such as publisher copyright permissions on a staff away-day, but that there was still "general ignorance" in her research community. This could be attributed to history and English literature being in the humanities domain where generally OA has not been widely adopted compared to the engineering and sciences disciplines. Nevertheless, some interviewees who belonged to engineering and sciences disciplines, HA1 (architecture and built environment) and HA2 (Allied health professions) were also not completely sure what OA entails. HA2 in particular, stated that although she was aware the university supports OA; she had not made use of the IR and said "*I don't really pay much attention as much as I should*". In addition, SP4 (politics and international studies) stated that while he acknowledged the importance of OA;

"the whole issue hasn't grabbed me...until I kind of get the sense that I need to be alarmed about it, I'm not going to pay much attention."

SP4's quote above suggests an absence of personal motivation to engage with OA until he has been "alarmed about it"; such an "alarm" could supposedly be an institutional policy that would play the role of altering his research dissemination behaviour.

In addition to attitudes towards OA, the interviews revealed a specific issue with regards to academics' perception of the relationship between OA repositories and academic impact:

5.7.2. OA repositories and academic impact

Some researchers made use of IRs but were not sure whether IRs facilitate academic impact. SP1, a politics and international relations academic for example, stated that while he acknowledged that work uploaded on IRs is more accessible than subscription-based content, he was unsure whether that directly translated to increased citations. Another interviewee, HP5 (Chemistry) concurred with this view and added that he uploaded papers on the IR only when he was required to do so. Similar to HP5, HP4, a computer scientist revealed that he has only recently started uploading his papers on the IR and said that he was "forced" to do so at his university: "*They say that you're more likely to get citations and all that stuff…"* The interviewer probed HP4 on his views on whether he agreed with this notion and he replied:

"My views on it are - don't worry about that, if you do good academic work, it will be cited anyway. Stop worrying about trying to bump it up by silly little ways, put your efforts into scientific discipline and don't worry about all that froth... if you do good quality work repeatedly, these things will go up anyway, you don't have to push them up.

Einstein never had to... he’s got more citations than anybody – he never heard of the repository or arXiv!” (HP4, computer science)

It seems from HP4’s view that repositories are not an important channel for disseminating his research and it is the quality of the work, rather than the channel used to disseminate the work that has an effect on citations.

Another issue that came to light was interviewees’ attitudes towards subject-based repositories:

5.7.3. Attitudes towards using subject-based repositories

In the quote above, HP4 implicitly states his disapproval for repositories, including arXiv – a subject-based repository normally used by academics in fields such as computer science, physics and mathematics; hence the interviewer was keen to hear from another computer scientist – HP3 on whether he made use of arXiv. HP3 explained that although arXiv was useful for uploading technical reports, which serve the purpose of claiming discovery of new ideas, but because it is not orientated towards peer-reviewed content he did not see any motivation for using it. In addition, another interviewee (HP2, physics) stated that he had not used arXiv, although he was unable to give the reason why this was the case.

In contrast to the three interviewees above, one interviewee, SA6 (media and cultural studies) valued the subject-based repository available to his research community. SA6 stated that he uploaded his work on Social Science Research Network (SSRN) in the hope that it would increase the citations of his work; he states his work on SSRN “*gets hit on and downloaded quite a lot so I assume that translates directly or indirectly into citations”.*

Interview responses also pointed to the relationship between the roles of OA and social media in facilitating impact: Social media is briefly mentioned here in the context of OA but explored more extensively in section 6.

5.7.4. Substituting use of repositories with social media

An interesting finding was that while other researchers used social media to complement repositories - institutional repositories (IRs) in particular; others used social media as a substitute i.e. uploading their papers on social media sites rather than repositories. One of them who substituted IRs with social media was HA5 (an education academic) who, referring to whether he had used IRs stated "*oh, I don't bother with those"* but instead, he uploads his papers on sites such as Academia.edu and Researchgate and gave an example of uploading his thesis on Academia.edu and Researchgate which he said had increased access to his work. Moreover, SA6 (media and cultural studies stated that because his university does not have an IR, he and a number of academics at his university were using sites such as Academia.edu to upload their work.

5.7.5. Other reasons for non-use of OA repositories

Other reasons for non-use of OA repositories were given by interviewees. HP5 (chemistry) revealed two others reasons why he was reluctant to use the IR; one of them was lack of time and the other was his preference to upload the publisher-formatted PDF versions of his papers, which would infringe most publishers' OA policies which mostly allow only the peer-reviewed author manuscript to be uploaded. Some interviewees were less cautious than HP5 and revealed how they had infringed publisher copyright by self-archiving publisher-formatted PDFs on their personal website (HA2, Allied health professions) or through downloading a publisher-formatted PDF from a journal then "surreptitiously" email it to anyone who is interested in reading them (SA4, Business and management studies and HA5, education).

5.7.6. Summary on OA attitudes and practices

The interviews gave some insight into academics attitudes towards OA. Firstly, it seems that it was mostly interviewees from Pure disciplines compared to Applied disciplines who questioned whether OA facilitates academic impact. Secondly, it transpired that some academics were using social media as a substitute for disseminating their work – these were mostly Applied disciplines. Thirdly, only one interviewee from an Applied area made use of a subject-based repository (SSRN) as he hoped downloads on it could translate to citations. In contrast an interviewee from a Pure area was not happy with that the subject-based repository available to his community (arXiv) was not orientated towards peer-reviewed content, so did not make use of it.

5.8. Social media: an ‘appropriate’ platform for research dissemination?

One of the interview questions attempted to uncover whether academics were making use of social media for their research activities. Some interviewees found social media sites such as Twitter useful for tweeting and re-tweeting links to OA journals (SA4, business and management studies and SA2, education). SA4 for example uses Twitter quite regularly for commenting on erroneous news items and for promoting her research. She described her Twitter network as predominantly academics, journalists, politicians and trade unionists, and said for non-academics interested in one of her papers promoted on Twitter, she downloads the PDF “surreptitiously” and sends it to them.

Other interviewees however, revealed their misgivings about social media being an ‘appropriate’ channel for disseminating research;

> “There’s something about going to all that trouble and effort to get it within an academic journal and being peer-reviewed, and I don’t mind it being freely shared, but putting it on something like Twitter or Facebook kind of almost ... not devalues it, but it ... Facebook is all about “hi i’ve just been down to a burger and a milkshake”. It doesn’t seem to be the right forum for a very serious professional…” (HA2, allied health professions)

> “No, definitely not. Yeah i just don’t personally find it’s the appropriate platform for it” (HP2, physics).

With the above quotes in mind, the interviewer was keen to uncover whether this ‘inappropriateness’ was due to cultural practices within interviewees’ disciplines or whether it was due to their personal circumstances such as age and hesitancy to use technology.

5.8.1. Social media and disciplinary cultural practices

There seems to be evidence particularly from interviewees in Hard disciplines that their non-use of social media was as a result of cultural practices in their disciplines. HP5 (chemistry) for example, an academic with 30+ years’ of research experience described the chemistry community as “conservative” and stated that as far as he was aware, even the newly experienced researchers were not using social media in their research activities. In addition, another academic, HP3 (computer science) stated that:

> "I have the impression that in my community nobody really seriously uses that for dissemination of results or anything… I don't think we use any of these publicly accessible channels so much because we don't see any, I guess any use" (HP3, computer science)

Another computer scientist, HP4 concurred with HP3's view and stated that because his is a small research community worldwide "*the good stuff goes into one particular journal*" therefore researchers who need to learn of latest developments in the field would consult the journal not social media sites.

In contrast, some researchers in the Soft disciplines pointed to a culture of social media use in their disciplines; for example SA6 who described colleagues in his research community - media and cultural studies as *"very digitally engaged*", and therefore, activities such as blogging about one's research have been common for a long time. SA6 added that although he has stopped traditional blogging he had begun using 'micro blogging' sites such as Twitter to raise awareness of his research. In addition SA1 (education), referring to social media use of both academic oriented sites such as Academia.edu and Researchgate and other general ones such as Twitter in his research community - e-learning - stated: "*things like that are more of what we do".*

Others only made use of general social networking sites such as Twitter and Facebook rather than academic-oriented ones. The reasons for this as explained by SA4 (business and management studies) for example, was because other colleagues in her research community did not make use of them because they were "slow adopters". She therefore, did not find such platforms useful as a channel for disseminating her research. Another interviewee however, SA3 (business and management studies, SA3 stated she did not use any social media sites at all because others in her research community did not do so.

5.8.2. Social media use and hesitancy to use technology

There was evidence from the interviews of academics who were hesitant to use technology. HA5 (architecture, built environment & planning) was concerned, "as with a lot of people in my generation" that there was neither guidance as well as time to use social media. In addition, HP1, a biological scientist referred to himself as a "technophobe" who does not use social media in both his personal and professional life, while INT1 (clinical medicine and computer science) described himself as "rubbish at IT" - this seemed to be a recurring theme among various other interviewees:

"I should be doing more with them! I struggle with that a little bit, and I think that's got more to do with my age than anything else, because all of this is sort of new to me, i know it's been around for a quite a while". (SP5, English literature and history)

"...this is where I do feel conscious of my age; I don't feel particularly IT literate or competent." (INT3, public health services & sociology)

"I'm afraid, that's a generational thing, I'm afraid I wouldn't... especially the academic ones you stated. Facebook and Twitter, I've not personally been involved with." (HA4, public health services)

The underlying theme in the three quotes above is a hesitancy to use technology as a result of age. An interesting case in relation to this is HP5 who, in addition to the 'conservatism' in the chemistry community stated above, also described himself as *"I'm at the end of my career maybe less tech-savvy than others".* This suggests that use and non-use of social media may be attributed to *both* the culture in the discipline and personal circumstances such as hesitancy to use technology and age.

5.8.3. Summary on social media

Whilst some interviewees reported using social media for various activities, the majority of interviewees did not make use of social media due to a mix of factors such as hesitancy to use technology and age, disciplinary cultural practices and lack of time. While there seemed to be disciplinary differences with regards to social media use/non-use between Hard and Soft disciplines (with those in the

Hard disciplines predominantly not using social media) there were no differences when comparing Pure with Applied disciplines.

5.9. Public engagement

Interviewees stated having taken part in various activities such as public lectures, school presentations, library displays, TV interviews etc. in a bid to engage policymakers, practitioners or the wider public with their research. It emerged from some of the responses however, that there existed a disparity between the university's interests in public engagement and an academic's individual interests.

5.9.1. Institutional influence on public engagement

Some interviewees explained how for example, they had been actively encouraged by their institution to target one particular audience - schools. SP3 (history) felt that her university encouraged engaging with schools, *"probably to raise aspirations rather than us disseminating our research"*. The same opinion was given by HP1, a biological scientist who mentioned that he felt public engagement activities at his university were "*to increase its profile and probably attracting more students in this competitive environment".*

Other interviewees explained how they felt pressured to target groups that were irrelevant to their research. For example, SA4, a business and management studies academic who stated that, because she belonged to a business school how she was expected to target business or law firms:

> "...vice chancellors tend to like it when their business schools or their schools of management are going off to talk to PWC or Accenture or some big law firm or whatever, and that's kind of not what I do - absolutely, emphatically not what I do… and they don't get, usually why you would be in a business school if you don't do that." (SA4, business and management studies)

Unlike the above interviewees, others felt that although they were actively encouraged by their institution to take part in public engagement, they were happy to do so. INT2 for example, an electrical engineering and education lecturer mentioned that she had done a number of presentations in schools which had been facilitated by both personal and professional relationships at those schools. In addition, HA3 (electrical and electronic engineering) stated that he had voluntarily signed up with his department's outreach programme and also takes the initiative in seeking out any public engagement opportunities with different organisations and the wider public. Another interviewee, SA2 (education) preferred public engagement not only being actively encouraged by institutions but also being "*formalised as part of an appraisal system".* This was an interesting opinion which the interviewer sought to hear whether other academics in subsequent interviews agreed with.

5.9.1.2. Formalising public engagement as part of an appraisal system

Most interviewees did not seem to share SA2's view, as illustrated in the quotes below:

"Well I don't think we want to get too rigid about this. I think it needs to be there yes, but I don't think it needs to be a barrier to promotion. There are people who for many years do lots and lots of fundamental research without it being relevant to the public, and then after 5 years or 10 years, suddenly it becomes relevant to the public and then they can engage with the public." (HA5, architecture, built environment and planning)

"...it would certainly disadvantage us, it would certainly put a label of 'uselessness' on people like me, which I'd strongly object to, I think we are pretty useful... I think we would be disadvantaged by this…" (HP3, computer science)

"If I was forced to do it, it wouldn't be as pleasurable, so, I mean, ok we're at work perhaps work shouldn't be always as pleasurable, though I think people should be allowed to, and given the room to devise their own ways of accessing the public attention." (SP5, English literature and history)

HA5's quote above highlights an interesting point about how basic research, which may not have been relevant at the time it was undertaken may become relevant after many years. With regards to the other two quotes; it seems the reason why HP3 did not view formalising public engagement favourably was to do with how he went on to describe his research as too complex to explain to lay audiences. SP5, on the other hand, although she had carried out engagement activities such as displays in the local library, she was concerned that there was not much interest in her research area, Victorian and Gothic literature as opposed some of the colleagues in her department who specialised in football history which was more popular with the public. SP4 (politics and international relations) in addition, stated that public engagement was *"not a good vehicle"* for disseminating the type of research he does in critical policy studies.

SP4's views however were in contrast to two other politics and international relations academics – SP1 and SP2. SP1 whose research is in counterterrorism and policing gave examples of how he was actively involved in disseminating his research at events attended by non-academic audiences such as the police and parliamentarians. In addition, through his research in peace-building, SP2 has been involved in debates at events which included audiences such non-governmental organisations and the police.

5.9.2. Summary on public engagement

Interviewees explained having taken part in a wide array of public engagement activities. School presentations were the only public engagement activity which exhibited disciplinary differences, whereby those who took part in school presentations were predominantly from Hard disciplines. It also transpired from some responses that interviewees felt their academic autonomy being encroached upon by their institutions encouraging them to engage with particular audience groups at the expense of those which were relevant to them. There however seemed to be no disciplinary group differences in this regard. In addition, most of the interviewees disagreed with the notion of public engagement activities being formalised as part of an appraisal system.

5.10. Articulating 'research impact'

Interviewees were asked what the phrase 'research impact' means in the context of their research and what aspects it encompasses. From the interviewees' responses, it transpired that the phrase research impact was synonymous with one of its two components – socio-economic impact. The academic impact component was only mentioned by academics in the hard/pure disciplines. For the socio-economic component responses ranged from abstract concepts such as 'changing people's minds' to tangible concepts such as "producing a product". The researcher used a categorisation by the Economic and Social Research Council (n.d.) of socio-economic impact to group these responses as shown in Fig 5-9 below:

- Conceptual: contributing to the understanding of policy issues, reframing debates
- Instrumental: influencing the development of policy, practice or service provision, shaping legislation, altering behaviour
- Capacity building: through technical and personal skill development.

These categories are applied to interviewees' responses as illustrated below:

Fig 5-8: Interviewees' articulation of impact

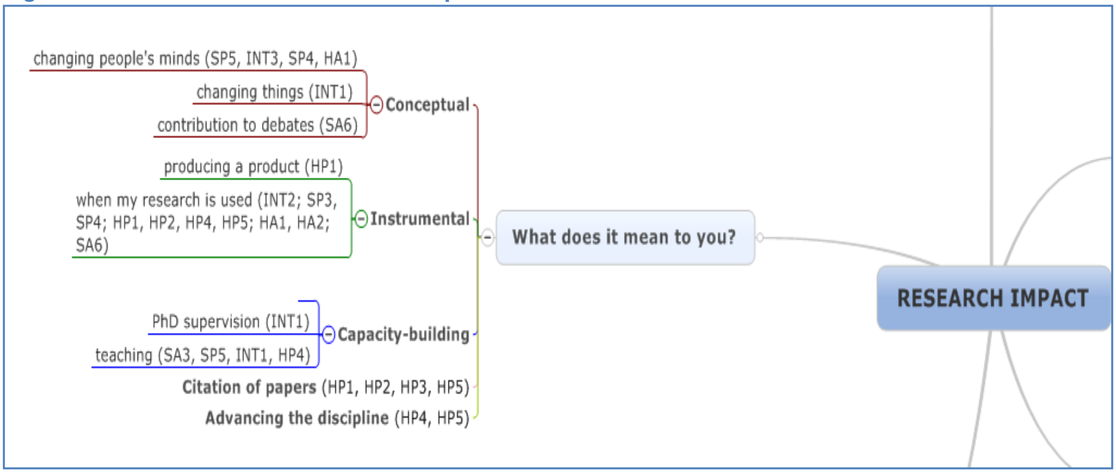
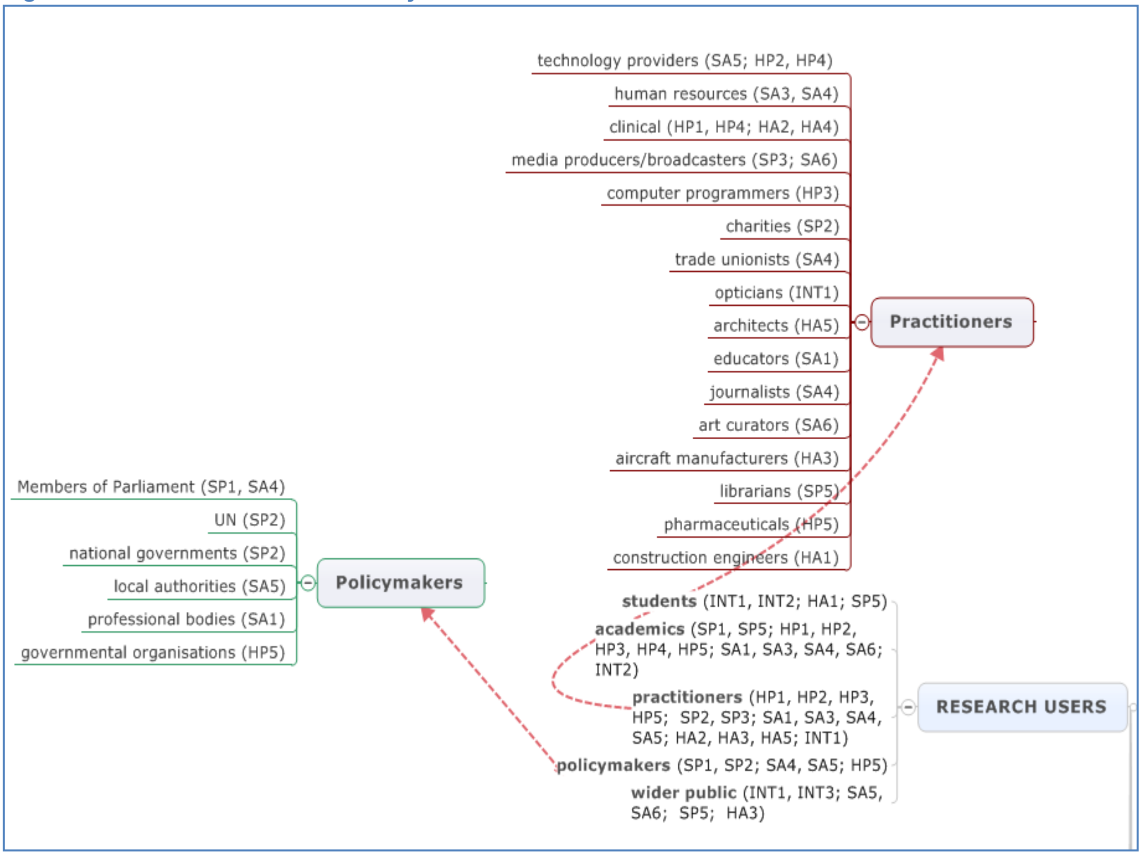


Fig 5-9 shows that in addition to the three categories of socio-economic impact, five interviewees identified research impact in the form of the inter-related concepts of 'citation of papers' and advancing the discipline (academic impact). These five were from computer science (HP3, HP4), physics (HP2), chemistry (HP5) and biological sciences (HP1), all hard/pure disciplines. The diagram shows that one can perceive what research impact means to them in more than one category, for example, HP1 also identified research impact as 'producing a product' under the instrumental category. In addition INT1 states PhD supervision and teaching (capacity building) and the more abstract – changing things (conceptual). This shows how academics may have various perception of what 'research impact' entails.

The interview also sought to uncover which groups interviewees viewed as their research users. So for example, if academics say "changing people's minds" in their definition of impact, who are these 'people', they refer to? Fig 5-10 shows the research users identified by the interviewees:

Fig 5-9: Research users identified by interviewees



The red arrows specify which particular types of policymakers and practitioners are identified by interviewees. Mostly the interviewees from Soft disciplines identified policymakers as their research users, whilst there were no disciplinary patterns in relation to practitioners. The next two sub-sections include a discussion on interviewees' efforts in maximising the impacts of their research on the two groups – policymakers and practitioners

5.10.1. Impact on policy

Some interviewees stated that they had made efforts to make their work relevant to policymakers – with varying success. Some, from the Soft disciplines (particularly the soft/pure quadrant) compared to Hard disciplines, vented their frustrations at 'politics' being a factor in their research not being taken up by policy makers. SP1 for example explained that policymakers at the Home Office for example, were potential research users but stated that although he sensed that civil servants there were receptive to his research, the government however was not because his research challenged government policy:

"…this current government in particular is not particularly interested in anything that contradicts what they are saying. So it's kind of like, well, if you don't like what we're saying, we are not interested in your work… so that's a bit of a shame, but I mean generally, civil servants and police officers are interested..." (SP1, Politics and international studies)

SP5 had faced similar challenges:

"...we're often kind of the people who don't have right, or even right of centre political, ideological ideas… we're dismissed as woolly lefty liberals! And I think for all of those reasons I would be surprised if policy-makers really wanted to listen to us. I mean, I know there is this kind of, you know, the lip-service being paid, but I think in reality, because they think we are just a bunch of woolly liberals." (SP5, English literature and history)

SP2 on the other hand talked of his experience on how he found policymakers at the UN inaccessible:

"Getting into the UN is one of the hardest things I've ever done in my life! Despite having the appearance of being the world's lifesaver, is ultimately inaccessible to many people. Build on giant pyramids structures of power, and has a very narrow understanding at times of what people need, and wastes money on an epic, epic level." (SP2, Politics and international studies)

Another interviewee, SP3 a historian, explained how the prestige of a university determined whether policymakers are receptive of research, she stated how she had struggled in a "*market where Oxbridge academics are the first ones to be listened to".* However, one interviewee, SA4 (business and management studies) had been successful in getting the attention of policymakers; through what she described as "career-long" networks, this resulted in giving evidence at the Houses of Parliament and also some of her work being published in policy briefings.

There seemed to be no apparent differences when comparing Pure with Applied in relation to interviewees' efforts on making an impact on policy.

5.10.2. Impact on practitioners

Various interviewees stated their wish for their research to make an impact on practitioners; some of their frustrations were discussed in section 3.1 under the heading of academic autonomy. In this section more detail is given with regards to the efforts interviewees are making to get access to practitioners, as well as the barriers faced.

5.10.2.1 Getting access to practitioners - facilitators

In addition to publishing in practitioner journals and magazines as was highlighted by academics such as INT2 in section 3.1; two interviewees stated how they had made efforts to use public relations (PR) consultants to help in both writing and disseminating their research in non-academic outlets such as newspapers, magazines and practitioner journals, with the hope of getting the attention of practitioners. SA3 (business and management studies) for example, had written about seven publications with a PR consultant but was not sure yet whether her research was being read by her targeted audience – human resources practitioners. She however stated that she was grateful to the PR consultant, saying she would otherwise have "*absolutely no idea of publicising her research on her own*".

Some interviewees stated how they have relied on their students (past or present) to provide networks within their (students') organisations. This was explained by the two business and management studies interviewees:

"...students very often go on to become senior people, they are bright young things, with stellar careers, and so keeping those networks, particularly the ones that are in the local area, or in the UK at least." (SA4, business and management studies)

"… if I get access to an organisation, it's generally because, either I know somebody who works there or I have a student – an MBA student who has worked there or is currently working there – something like that." (SA3, business and management studies)

5.8.2.2. Getting access to practitioners - barriers

Some interviewees vented their frustrations on how some practitioners were not "innovative" or "forward-looking" hence their reluctance to use academic research. The following quotes by SA5 and HA5 reflect this:

"…public transport providers are just not very innovative, quite most of the time they were really not that bothered, and I think they are so tied by certain regulations and things like that as well, because sometimes it could stop them wanting to be innovative... So yes, sometimes the people that could enable you to have the most impact might not be the ones that engage with you." (SA5, art and design)

"There are other companies who aren't very forward-looking, very short-sighted and to them it isn't worth their while investing the time to look at what it is that we've got to offer." (HA5, architecture, built environment & planning)

It is noteworthy that, while SA5 suggests the culture of aversion to innovation by public transport providers as being shaped by external factors such as regulatory controls; in HA5's case, it seems to be an internal factor whereby companies are merely reluctant to engage with academic research.

Another problem faced by academics, as explained by INT2 (electronic and electrical engineering and education) was targeting organisations who fail to disseminate her research widely throughout the organisation. Initially it seemed to the interviewer that this may have been an issue of relevance, whereby INT2's research may have been relevant to a particular part (or department) of an organisation, whilst not being relevant to others. Upon further probing it seemed the problem was more of organisations not having effective knowledge sharing practices, hence one part of an organisation not being aware of what was going in another part of the organisation. INT2 added that she had taken steps to target the organisations' internal communication channels such as magazines, although she was unable to say how effective this had been.

Some of the frustrations related to an absence of networks/links with practitioners. SE for example stated that only those of her colleagues who were involved in consultancy work with organisations were more likely to be able to evidence the impact of their work because of their long-standing links and rapport with those organisations.

5.10.3. Summary on articulating research impact

Some academics have various perceptions of what 'research impact' entails, and some of these perceptions may not be taken into account by policy. Moreover, the interviews highlighted that for most interviewees the phrase 'research impact' was synonymous with the socio-economic component only. It is only those from Hard disciplines who included the academic impact component in their explanation of what 'research impact' means in the context of their research.

Whilst *politics and the prestige of a university* appeared to be barriers for researchers trying to make their work relevant to policymakers; for practitioners it was *organisational culture*, encompassing organisations' unwilling to innovate and poor knowledge sharing practices which emerged as the primary barrier. With regards to disciplinary group differences, it is more of the interviewees from Soft disciplines compared to those in Hard disciplines who noted how their research was relevant to policymakers - there were no disciplinary differences between Pure and Applied disciplines in this regard. However, the reverse was true when considering practitioners; again, whilst there seemed to be disciplinary differences between Pure and Applied disciplines (whereby it was more of the interviewees in Applied disciplines who stated that they had made efforts to engage with practitioners) there were no apparent differences when comparing Hard and Soft disciplines.

When comparing across quadrants, researchers exclusively from the hard/pure quadrant include the phrases “citation” and “advancing the discipline” when articulating what ‘research impact’ means to them. Moreover, it seems it is mainly researchers from the soft/pure quadrant who are frustrated by the ‘politics’ and disinterest of policymakers in their efforts in attempting to make an impact on policy.

5.11. Measuring research impact

Another key issue from the interviews is the consideration of how the socio-economic impacts of research might be measured. Most of the interviewees explained that they were not aware of how this might be done; whilst those who stated that they did know, did not seem keen to be drawn on the specific details. Only one interviewee, SP2 (politics and international studies) stated how they used a method called ‘most significant change’ in his field which involves research users, not researchers creating impact indicators, for example reduction in illness. A survey is used for research users to answer the question: “What’s the most significant change(s) in your lives as a result of the project?” SP2 explained that the time lag until the impacts of the projects can be felt varies, but it can be as short as 6 months.

One interviewee stated how he had been asked to do an internal assessment of submissions for the REF but found it challenging:

> “...I was asked to measure the impact of two people last year and I was out at sea, and I had to do it! And I had to go to a couple of my colleagues who do this regularly, because our university gets our research leads to measure each other’s impact, and they sit down with each other’s papers before deciding whether those people are entered to REF. Now, I was always out at sea, I was terrible at doing that...” (INT1, clinical medicine and computer science)

Furthermore, it seemed most interviewees’ responses on the perceived difficulties in measuring socio-economic impact were a primary influence on how negatively they viewed the REF as a research evaluation mechanism. This was not the case though with all interviewees; for example, SA6 (Media and cultural studies) who stated that although socio-economic impact is expressed "as some kind of economism" whereby there is more focus on sales and economic returns, at the expense of other non-economic benefits, the case for public accountability through the REF was important. Another academic stated that she did not have any concerns with the way socio-economic impact was measured, but rather, as a researcher with interests in electronic and electrical engineering and also education, she stated that her research spans disciplinary boundaries and *"does not fit into pigeonhole"* the way it had been done for the REF. HP5 (chemistry) also seemed to be concerned with how he was submitted under the chemistry unit of assessment for the REF, and states when

> "...a lot of what we do is actually biomedical sciences or petrochemical science or pharmaceutical science or environmental science, and it's actually hard for those really genuinely interdisciplinary disciplines can lose out because they are not seen as the core of the traditional discipline in there, and that's always an issue to us." (HP5, chemistry)

This assertion by HP5, together with INT2 shines light on how in research assessment 'traditional' disciplines take precedence over newer disciplines which straddle the boundaries of other disciplines and how in some circumstances policies for research evaluation mechanisms may not take this into account.

5.11.1. Incorporating 'teaching' in research evaluation

Although unable to state how this would be measured, some interviewees stated their wish for teaching to be included in research evaluation (for REF 2014 only teaching that has a significant influence beyond one's institution was considered for evaluation):

> "One of the immediate, right-on-our-doorstep impacts is teaching, you know, getting that research out in the classroom..." (HA5, Architecture, civil and building engineering)

> "I am here as a teacher teaching undergraduates and postgraduates, that is important to me, that is a really good thing. So even if I don't produce a paper, even if what I do never impacts on the world my students are going to have an impact on the world, wow, yeah, they're going to go places... because teaching is about generating the

future - and actually, how interesting – you could say: ‘ok what is your impact?’ Now I’ve been teaching for 22 years, I teach approximately 1/6 of the course, and in that 22 years we’ve graduated 2200 optometrists, and each of those has gone out there, tested people’s eyes” (INT1, clinical medicine and computer science).

In contrast to HA5 and INT1 above, HP4 (computer science) stated that although he acknowledged the impact of his research on teaching, he agrees with the terms of last REF which puts a line between academic impact and teaching impact by measuring the impact from one’s publications and *“then that’s a natural process that feeds into your teaching.”* Therefore, he argued, there was no need of evaluating it separately.

5.11.2 Attitudes towards altmetrics

Another issue that came to light was the contribution of social media in measuring impact, against the background of alternative metrics (altmetrics), which involves giving a metric score obtained from various sites measuring the impact of a paper through for example ‘likes’ on Facebook, tweets on Twitter, downloads, shares and views etc. from various platforms. Only two interviewees (HP3, computer science and INT1, clinical medicine and computer science) were aware of altmetrics, albeit with contrasting views about their suitability. HP3 had the following view:

“I think this would not really help at all for me and my colleagues, because we do not communicate our research like this. We use email, one-to-one communication, it’s more workshops, it’s more conferences so that is how we get together. Email is still a very important thing for us, I don’t think we use any of these publicly accessible channels so much because we don’t see any, I guess any use, so I think this altmetrics would not help at all in our case” (HP3, computer science)

HP3’s argument against altmetrics above is based on social media not being customarily used as a means for disseminating research in his research community. This can be contrasted with others such as SA3 and SP1 who were more concerned with the rigour and quality of items that are ‘tweeted' or ‘liked’ on social media. SA3 and SP1 had no prior knowledge of altmetrics but were keen to share their thoughts, they said:

"It’s interesting, I don’t know if a like on Facebook or a retweet is actually impact…how do we really know what the ‘like’ means" (SA3, business and management studies)

“… it’s kind of like a journal, you publish a good article in a bad journal and you get less likes because of the quality of the journal, but the article might actually be better than an articles published in a top journal which is referenced and more prestigious… the ‘likes’ aren’t necessarily linked to the quality of the paper.” (SP1, politics and international studies)

The above quotes question how a ‘like’ or ‘tweet’ would be able to assess the quality of a paper. SP1’s quote highlights one of the issues with that have long been associated with bibliometrics whereby journal metrics such as impact factors which play a role in ‘branding’ journals may not reflect the quality of all the articles published in them.

5.11.3. Summary on measuring research impact

All interviewees except one were unable to explain how the socio-economic impacts of their research might be measured. It seems unawareness or uncertainty of how socio-economic impact might be measured was a primary influence of how some researchers negatively viewed the REF as a research assessment mechanism. Moreover, some researchers saw their research as having an impact on their teaching activities and stated their wish for this to this incorporated in the REF.

The interviewees also revealed that some academics were not confident in the effectiveness of altmetrics as an alternative method of research evaluation; this is compounded by the fact that some did not view using social media as an appropriate platform for disseminating research.
No disciplinary differences were apparent in this section.

5.12. Summary of chapter

The following points summarise the findings from the interviews:

- Academics in Pure disciplines compared with Applied disciplines tend to collaborate with others within their discipline, whereas, there is no consistent disciplinary pattern for those collaborating with academics outside their discipline. As expected, collaborations with non-academics are mostly done by those in Applied disciplines. There seemed to be no disciplinary differences with regards to collaborative activities when comparing Hard with Soft disciplines.
- Whilst some academics were able state for that they had experienced impact on their research activities as a result of using openly available data, the same could not be said for sharing data.
- Constrained academic freedom manifested itself in two forms;

  i) decisions on the types of research outputs to produce and where to publish them - it appeared that it was more of the interviewees in Applied disciplines, compared to Pure disciplines who reported having their dissemination decisions influenced by their department/school. There seems to be no apparent differences between Hard and Soft disciplines.

  ii) decisions on the type of public engagement activity taken – some academics felt pressured to engage particular audiences such as schools.
- There seems to be evidence of disciplinary cultural practices shaping social media use/non-use; with those in Soft disciplines stating that they use it, as opposed to those Hard disciplines (there seemed to be no apparent differences between the Pure and Applied disciplines). However, other factors such as age and hesitancy to use technology also explain whether academics use social media or not.
- Some academics were not confident in the effectiveness of altmetrics as an alternative method of research evaluation, this is compounded by the fact that some did not view using social media as an appropriate platform for disseminating research
- Some academics were unsure about how repositories facilitate academic impact.
- While some researchers used social media to complement institutional repositories; others used social media as a substitute
- Academics have various perceptions of what ‘research impact’ entails

- Whilst *politics and the prestige of a university* appeared to be barriers for researchers trying to make their work relevant to policymakers; for practitioners it was *organisational culture*, encompassing (organisations' unwilling to innovate and poor knowledge sharing practices) which emerged as the primary barriers.
- The perceived difficulties in measuring socio-economic impact were a primary influence on how negatively or positively interviewees viewed the REF as a research evaluation mechanism.

Chapter 6: DISCUSSION

6.1. Introduction

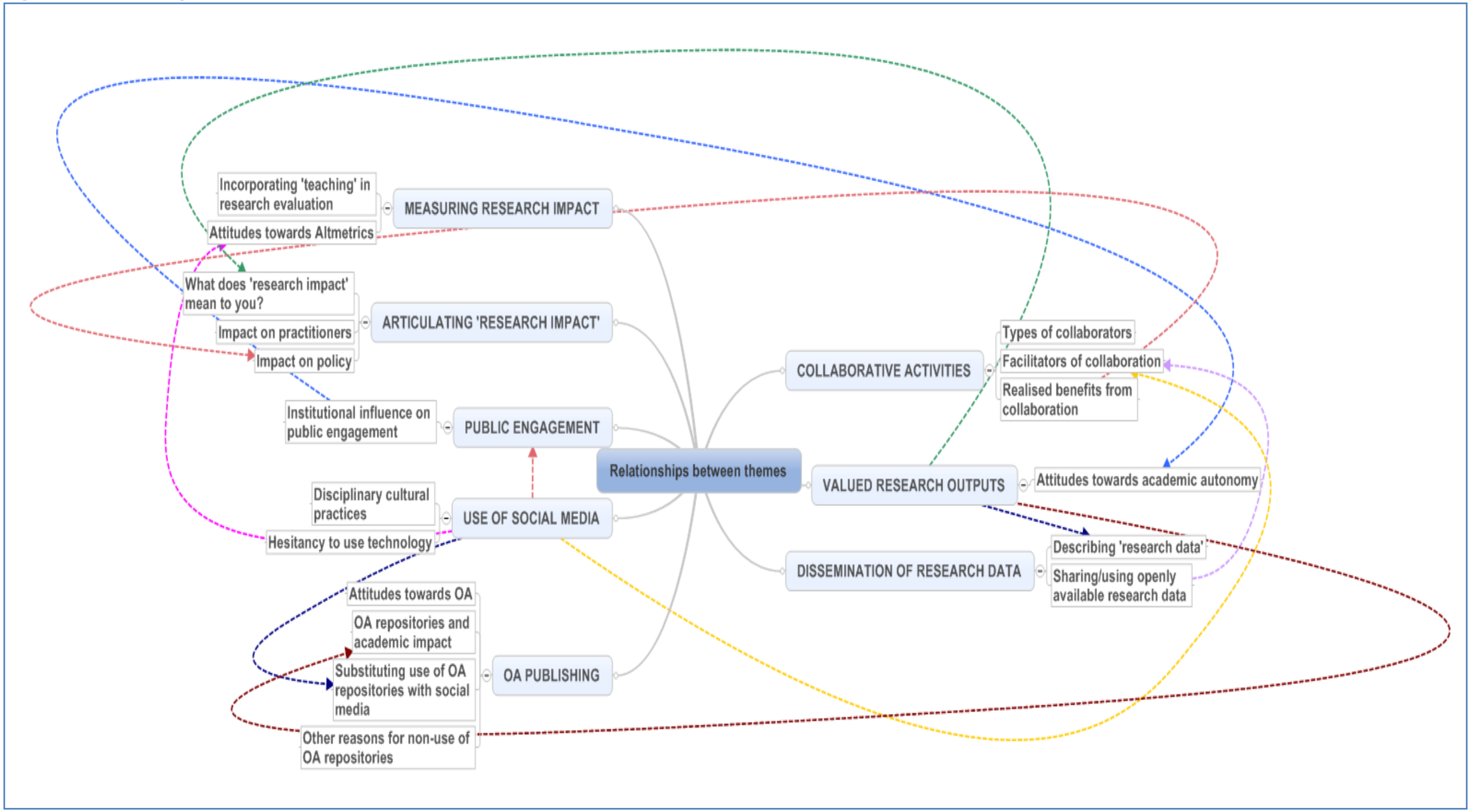
This penultimate chapter integrates the findings of the previous two chapters – consisting of survey questionnaire and interviews findings, relating this with the theory from the literature, within the context of the study's three research questions:

- *What are the types of research outputs produced by researchers in different disciplines, what are the channels used to disseminate them, and who are the types of intended audiences?*
- *What role does sharing/using openly available research data play in achieving research impact in different disciplines.*
- *What are researchers' attitudes towards the current methods and frameworks used for evaluating research impact in their disciplines (as categorised by Becher (1987) typology)?*

The chapter is divided into eight sections as shown by the blue-shaded rectangular boxes in Fig 6.1. The discussion begins by first looking at research practices such as *collaboration* and the *research outputs* valued by researchers, and then discusses how these research outputs are being made *OA* and examines attitudes towards the principle of OA. From OA publishing the discussion moves on to look specifically at *dissemination of research data*; whether research is being made openly available and the different perceptions of the term 'research data'. The discussion then proceeds to the role of social media in research dissemination and then the efforts researchers are making to engage non-academic audiences with their research – *public engagement*. The discussion is then concluded by looking at how researchers *articulate the phrase 'research impact'* and what research impact means to them in the context of their research and *how it might be measured*.

The eight themes are inter-related and not mutually exclusive. For example, as shown in Fig 6.1, the two themes *collaborative activities* and *dissemination of research data* are linked by the role sharing/using openly available research data plays as a facilitator of collaboration, as shown by the purple arrow. Moreover, *use of social media* and *'measuring research impact'* are linked by attitudes towards altmetrics (as shown by the red arrow).

Fig 6-1: Relationships between themes



6.2. Collaborative Activities

This section looks at the collaborative activities undertaken by researchers in the study and how this relates to theory from the literature. The purpose of questions on collaboration in the study was to uncover from participants - in line with the research questions stated above - who they were collaborating with, what facilitated such collaboration and whether any benefits were realised as a result. As this is an introductory section to the chapter, some aspects of collaboration are mentioned briefly in this section and then discussed in more detail in the relevant successive sections.

6.2.1. Types of collaboration

Findings from both the survey and interviews provided a picture of the types of collaborative activities undertaken by researchers. The survey showed that those from Hard (as opposed to Soft) disciplines were collaborating with researchers predominantly within their *research group*. This might be because Hard disciplines are characterised as having a ‘paradigm’ (Biglan, 1973b, p.210), and according to Biglan this allows for greater ‘social connectedness’ among scholars on their research. Although the survey showed no evidence of an association between the disciplinary group to which respondents belonged and whether or not they had collaborated with *international collaborators*, there was evidence from the interviews highlighting that a greater proportion of academics in Applied as opposed to Pure disciplines were collaborating with international scholars. This might be because pooling of resources (including funding and equipment) and expertise to solve problems

The interviews also showed that beyond the academic community, while there were no apparent differences when comparing Hard and Soft disciplines, academics from Applied and Interdisciplinary areas reported more often than those in Pure disciplines that they collaborated with *practitioners*. This confirms the notion that, because of more external sources of influence on their research and a higher degree of concern for application to practical problems, as argued by Biglan (1973), academics from Applied disciplines are more externally-facing (with policymakers or practitioners for example) than those in Pure disciplines. The idea of collaborations with practitioners will be discussed in more detail in section 6.8 which explores researchers' efforts in maximising the impact of their research by working with practitioners.

6.2.2. Facilitators of collaboration

Interviewees in the study spoke of building their collaboration networks mainly through conferences, social media and their former PhD supervisor(s). Such networking activities have been distinguished by Goel and Grimpe (2013, p.117) into “active” and “passive” networking activities. Active networking involves activities such as conference attendance, which are consciously undertaken by researchers, having spent time and money considering the relative costs and benefits (Goel & Grimpe, 2013, p.117). In addition to attending conferences, two researchers also stated that they networked with potential collaborators via social media – both academic oriented (LinkedIn, Mendeley etc.) and general social networking sites (Facebook, Twitter etc). Social media use, is stated briefly here but will be discussed in section 6.6.

The other type of networking activity – passive networking - involves collaborating with well-known researchers who are connected to a larger pool of potential collaborators (Goel & Grimpe, 2013, p.117). In this study, passive networking manifested itself through researchers who had been introduced to a wider network of collaborators through their former PhD supervisor(s) who they had kept in touch with several years after completing their PhD. The findings from the study, however, diverge from previous studies (Melin, 2000; Harley *et al*., 2010; Lewis, Ross & Holden, 2012) that have emphasised conference attendance as a primary facilitator for collaboration. Certainly, in this study more interviewees reported forming their social networks passively (e.g. through their former PhD supervisors) than actively (e.g. at conferences), and disciplinary differences were not apparent.

6.2.3. Benefits of collaboration

Researchers reported having realised a number of benefits as a result of collaboration. The study identified that such benefits were more aligned to tangible outputs from research activity (e.g. ‘increased publications’) than intangible benefits such as personal development of researchers (e.g. 'broadened skills set', 'different perspective on methodology'). The importance of increasing publications could be attributed to the notion that publications yield recognition, which helps in acquiring additional funding, which in turn forms the basis for new research activities (Van Riijnsoever & Hessels, 2011, p.464) and institutional rewards, for example, promotion.

It has been suggested that one of the pitfalls of collaborative research is the hindrance to (particularly junior) researchers' career advancement, whose contribution to research done with a well-known researcher may be undervalued by a tenure committee (Sonnenwald, 2007, p.651). This notion did not surface from the findings of this study. Another criticism is that collaboration, particularly with practitioners, erodes academic autonomy i.e. academics not retaining decision rights over the projects they take on and the methods they use to tackle them (Tartari & Breschi, 2012, p.1136). There was also no evidence of this in this study; however, researchers spoke of the challenges they faced at times in collaborating with practitioners and these are discussed in more detail in section 6.8.

6.2.4. Collaboration and research evaluation mechanisms

The interviews revealed a relationship between researchers' (particularly those engaged in interdisciplinary collaboration) collaborative activities and their attitudes towards research evaluation mechanisms. The first issue, also found in a study by Lewis, Ross & Holden (2012, p.700), related to researchers feeling that research evaluation mechanisms were limiting interdisciplinary collaboration by labelling and aligning them into specific units of assessment. In other words, they felt that their research was being 'pigeonholed' into units of assessment that did not wholly represent their work. Related to this are concerns by some researchers who struggled to find appropriate journals to publish their articles produced as a result of interdisciplinary collaboration; for example, a business and management researcher who was involved in interdisciplinary collaborations with an education researcher, had faced challenges in finding a suitable journal that accommodated both of their disciplines. Although this was not a common issue among the researchers considered for this study, it is pertinent to the concerns raised by Rafols *et al*. (2012, p.1280) who found that widespread use of ABS (Association of Business Schools) journal rankings in business and management studies result in a bias in favour of disciplinary research, at the expense of interdisciplinary research which is perceived as being of lower quality. REF 2014 submission guidelines stressed all forms of research were to be assessed on a “fair and equal basis” and made reference to interdisciplinary and collaborative research in particular (HEFCE, 2011, p.4). This suggests that although interdisciplinary collaboration is being actively encouraged at the research funder policy level, at the institutional level, because of structures such as ABS journal ranking lists which have become influential in the selection of outputs for submission for research assessment (Mingers & Willmott, 2013, p.1052) researchers particularly in business and management are under pressure to publish in the top ranked journals on the ABS list, which as found by Rafols *et al*. (2012), has bias against interdisciplinary research.

6.3. Research Outputs

As the conduit through which knowledge in different disciplines is communicated, and through which research is assessed, an understanding of the research outputs produced by academics was crucial. The survey asked respondents for an estimation of the number and types of research outputs they had produced over a five year period, whilst the interviews sought to investigate how important the type of outputs were to interviewees. The purpose of these questions from both the survey and interviews was to paint a picture of how research was being communicated in the different disciplinary groups, and what value researchers placed on particular types of outputs in relation to the outputs they were expected to produce in their departments/schools.

6.3.1. Valued research outputs

As stated in section 4.4.4, responses to the survey were not enough to perform valid tests showing whether there was an association between disciplinary groups and the types of outputs produced. However, it was possible to identify that the most commonly produced types of outputs were journal articles and conference papers, followed by book chapters, research reports and technical reports; whereas compositions, digital/visual media, physical artefacts, patents, performances were the least commonly produced research outputs.

Interview findings on the other hand, were able to identify disciplinary differences; monographs, conference papers and book chapters were more likely to be valued by those mostly from Soft disciplines, whilst technical reports were valued by those mostly from Hard disciplines, whereas practitioner journals/magazines, translated books/journals were valued by those mostly from Applied and Interdisciplinary areas. There were no consistent disciplinary differences for the academic journal as it was regarded as important by academics in all disciplinary groups. The fact that the survey revealed the academic journal as the most commonly produced research output, whilst the interviews revealed it to be considered important by researchers in all disciplinary groups was expected, and supports the findings of several other studies including Harley *et al.* (2010); RIN (2009) and Sparks *et al*. (2005). The importance of the academic journal to researchers appears to stem from peer review, which, as asserted by Becher (1989, p.61) serves to maintain the overall standards within the discipline. Also, because the academic journal, as argued by Rallison (2015, p.90) is important in measuring researchers' performance and productivity (largely due to the number of publications and the journals in which they appear), it has become "central to career paths", including both funding and appointments.

As stated above, monographs were highly valued by researchers in Soft disciplines (particularly soft/pure) as opposed to Hard disciplines. Monographs, as described by one historian in the interviews are the "really big deal" in her discipline. This supports various previous studies, for example, Dalton (2009) and Ballon & Westerman (2006) who found books to be important in history and art history respectively. The reason why books are important in such disciplines can be explained by Biglan's (1973b, p.210) contrast of Hard and Soft disciplines. Unlike Hard disciplines, which are generally characterised by the existence of a 'paradigm', in Soft disciplines, where paradigms are not characteristic, the scholars must describe and justify the assumptions on which their work is based, delimit their method or approach to the problem and then establish criteria for their own response to the research problem - more space than that available in journals will be required to accommodate this. For example, SP5 (English language and literature & history) explained that the monograph gives one “scope to explain” the background and the findings of the research.

The findings and the ensuing discussion on journal articles and monographs as stated above were expected but serve to corroborate previous work, by framing the discussion within the context of seminal works by Biglan (1973b) and Becher (1989) through identifying disciplinary group differences.

6.3.2. Attitudes towards academic autonomy

The interviews revealed evidence of some researchers, particularly those from Applied and Interdisciplinary (compared to Pure) disciplines feeling “pressured” to publish their work in highly rated journals at the expense of other outputs such as practitioner magazines/journals and translated works which they felt were more targeted to their intended audiences. This “pressure to publish” as characterised by one of the interviewees, and as found in other studies (Sparks *et al*. 2005; RIN, 2009) was in reference to the *type* of output, as opposed to the *quantity* of outputs as previously found by Ballon & Westerman (2006); Jones *et al*. (2001) and Elton (2000). These studies point to researchers being under pressure to produce as many journal articles as possible, so that there is a larger pool to select articles for submission for research evaluation – hence the phrase "least publishable unit”, used by Wheeler (1989, n.p.) to characterise fragmenting research results in order to produce the greatest possible number of publications. This is not limited to journal articles only, Harley *et al.* (2010, p.37) talks of archaeology scholars producing “a glut of books”. These findings did not surface in this study; none of interviewees stated being ‘under pressure’ from their academic department/school to publish as many of a particular type of output as possible, instead it was the pressure to select which types of outputs to publish their research and where to publish the research.

Using McNay's (2007, p.539) 'push-pull' analogy of the conflicting goals between academics and academic leaders, this study has shown that there appears to be a *push* by institutions (and their departments/schools) towards encouraging academics to publish in high impact journals, yet there is a *pull* by academics towards autonomy in selecting those outlets they see most suitable in disseminating their research. One way of further exploring this dissonance is through examining HEFCE's (2011) definition of what it considered as 'research' for the outputs submitted in REF2014, which it defined as:

> *"a process of investigation leading to new insights, effectively shared… it includes work of direct relevance to the needs of commerce, industry, and to the public and voluntary sectors…" (p.48).*

This definition touches on two aspects; the first being the production of new knowledge in order to advance the discipline, while the second relates to the usefulness of that knowledge to society. The interview findings therefore point to researchers, particularly from Applied and Interdisciplinary disciplinary groups who felt that research outputs such as practitioner journals, as opposed to highly rated academic journals, were most suitable for communicating such knowledge and making it more accessible to practitioners. By contrast, there was no such evidence from academics in Pure disciplines.

6.4. Open Access Publishing

Having discussed the research outputs produced by academics, this section focuses on the concept of OA to research outputs; the survey sought to uncover the channels researchers were using to make their research available via OA whilst the interviews sought to investigate researchers' perceptions and attitudes towards the principle of OA.

6.4.1. Most commonly used OA channels

The survey revealed that the most common route by which respondents made their work OA was through personal/project websites (67.3%), followed by IRs (53.1%) and OA journals (38.1%); with the least commonly used channels being subject-based repositories (14.2%) and funder repositories (10.8%). This corroborates previous studies (Mischo & Schlembach, 2011; Lyons & Booth, 2011; Kim, 2010; Swan & Brown, 2005; Antelman, 2004) which have found personal/project websites to be the most common channel used for making research outputs OA. The interviews revealed diverse reasons why researchers uploaded their work on personal/research websites; mainly *increasing readership* of their work and *convenience* (i.e. less time-consuming than uploading on OA repositories). 'Convenience', however, meant that at times adequate copyright checks were not followed by some researchers prior to uploading research outputs on personal/project websites, thereby prompting complaints from some publishers for copyright violation, particularly in cases where the publisher-formatted PDF had been uploaded. This concurs with Lyons & Booth (2011, p.114) who noted how some researchers were ignoring publisher archiving policies and uploading the wrong document version on their websites.

The low use of subject-based repositories was reflected in the interview findings. Only one interviewee (SA6 – media and cultural studies) reported that he used the subject-based repository, SSRN, because he perceived it to increase the number of citations to his work. Three other interviewees whose disciplines, physics and computer science are served by the subject-based repository – ArXiv stated that they did not use ArXiv. Lack of peer-reviewed content was cited as one of the reasons. This reason, and other reasons such as OA mandates requiring deposit of research outputs into IRs, and the fact that subject-based repositories are only available to research communities in particular disciplines, but not all, help to explain why more researchers use IRs than subject-based repositories. While this conforms to findings by Spezi *et al*. (2013), it diverges from research by Hahn & Wyatt (2014, p.97) who noted that business scholars found a "lack of value" to them in utilizing an IR, hence double the number of scholars had deposited their work in a subject-based repository than in the IR. In addition, Kim (2010, p.1914) whose study included a wider range of disciplines than Hahn & Wyatt (2014), from seventeen universities, noted more scholars having uploaded their research on subject-based repositories than on IRs.

6.4.2. Attitudes towards the principle of OA

While statistical tests did not show any differences between disciplinary groups and use of personal/project websites and the two least commonly used OA channels, subject-based repositories and funder repositories, they did however show disciplinary differences in IR and OA journals use. The tests showed that for IRs, there was a greater proportion of respondents in the Soft and Both Dimensions, than in Hard disciplinary groups who uploaded their work on IRs. Also, comparing Pure with Applied disciplines, a greater proportion of those in Applied and Both Dimensions than in Pure disciplines had uploaded their work on IRs.

The interviews revealed that researchers predominantly from Hard (particularly hard/pure) disciplines as opposed to the Soft disciplinary group used OA repositories as a way of adhering to university/funder mandates, yet some of these researchers questioned whether OA facilitates an increase in citations. This corroborates the findings of Spezi *et al*. (2013, p.343) who found that researchers considered funder and institutional mandates to be relatively unimportant as motivators for self-archiving. Other studies such as those by Kim (2010) and Rodriguez (2014) have pointed to altruism being a driver for researchers to make their work OA; there was no compelling evidence of that in this study, in fact, only one interviewee (SA2, education) talked about the “moral obligation” to researchers in poorer countries as the reason why she supported OA. Furthermore, unlike previous studies (Creaser *et al*., 2010; Hahn & Wyatt, 2014) which found some participants questioning the *quality* of work made available in OA channels, there was also no evidence of that in this study, rather, some interviewees questioned *how OA facilitated an increase in citations*. There was also some evidence of researchers, particularly from Applied (as opposed to Pure) disciplines substituting OA channels with social media; this is discussed further in section 6.6 which examines the wider issue of the degree to which social media has been adopted by academics in different disciplinary contexts.

The study revealed strong evidence across all disciplinary groups of an unawareness of OA and how IRs work, this is pertinent to the concerns raised by

Yang & Li (2015) and Rodriguez (2014). Rodriguez (2014, p.609) for example, noted some scholars having ‘misguided concerns, mistaken beliefs and confusion’ about what OA means. The interviews revealed examples of one researcher who was certain that her university did not have an IR, when in fact it did, and another who stated that the OA issue had not “grabbed” him. This implies that despite best efforts for advocacy of OA in recent years by institutions and by funding bodies, for example the RCUK (2012a) OA policy, some researchers are uncertain of what OA entails. There is a possibility however, that this may change in light of the HEFCE (2014) OA policy requiring submitted outputs for the next REF, particularly journal articles and conference proceedings to be uploaded in IRs and subject-based repositories on acceptance of publication.

6.5. Dissemination of research data

Having discussed open access to scholarly work in section 6.4, this section looks specifically at the issue of open access to research data. The survey served to establish whether researchers were sharing/using openly available research data, recognising their dual role as both potentially creators and users of openly available research data. It also served to quantify the proportion of researchers who were either using or sharing openly available research data, and any benefits realised as a result of doing so. The interviews on the other hand, sought to uncover how the term ‘research data’ was perceived by researchers in different disciplines and explore their experiences in sharing or using openly available data.

6.5.1. Sharing research data

The survey revealed that the majority of researchers (61.9%) had not made their data openly available anywhere on the internet over the past five years. This is in contrast to the findings of Tenopir *et al*. (2011, p.9) who found that only a minority of academics (46.0%) had not made their data openly available anywhere on the internet, (although a third of the respondents in Tenopir *et al*.’s (2011) survey chose not to answer the question). Higher rates of not making data openly available were found in other studies, for example, 76.0% of researchers in RIN’s

(2010, p.60) survey, and 80.7% in Andreoli-Versbacha & Mueller-Langer's (2012, p.1627) study. This implies that researchers, in the main, are not making their research data openly available; this is despite various policy initiatives such as the RCUK Common Principles on Data Policy (RCUK, 2011) promoting research data sharing, and advocacy by various scholars including Borgman (2012); Piwowar, Day & Fridsma (2007) and Lyon (2009), that making research data provides both academic and societal benefits. Academic benefits stated include increased citations to a journal paper linked to open research data (Piwowar, Day & Fridsma, 2007, p.2) and societal benefits include efficiency gains that result from reduced unnecessary repetition of research activity and associated wasteful funding allocations (Lyon, 2009, p.16).

6.5.1.1. Barriers to sharing research data

The most common reason why researchers were not sharing their data as revealed by the survey was 'lack of time'; 68.9% of respondents stated that they either 'strongly or somewhat agreed' that they did not have time to organise the data and make it openly available. The fact that lack of time was a major barrier to making research data openly available was an expected finding and has been highlighted in various other studies including Wicherts *et al*. (2006); Youngseek & Adler (2015) and Fecher, Friesike & Hebing (2015).

Chi-square tests did not show any disciplinary group differences relating to lack of time, this therefore implies that 'lack of time' is a barrier experienced by most researchers regardless of the disciplinary group to which they belong. The interviews supported this finding, as lack of time was a problem encountered by most researchers interviewed. There were, however, disciplinary group differences from the survey results when looking at one of the other barriers to making research data openly available – confidentiality, whereby a greater proportion of respondents in Interdisciplinary and Soft disciplines, compared to those in Hard disciplines, viewed confidentiality as a major reason why they were not making their research data openly available. This corroborates other sources Ceci (1988); Perry (2008) and Youngseek and Adler (2015) which found that researchers in social sciences and humanities (whose disciplines can be classed as ‘soft’) were not making their research data openly available because of confidentiality issues. Perry’s (2008, p.145) study in particular pointed to how many researchers, even under mandates from funding bodies to make their research data openly available, did not comply - citing confidentiality concerns. Indeed, some of the researchers in this study stated how they had managed to justify to their research funders not sharing their data because of the sensitive nature of the data. This is captured in one interviewee’s statement: *“… I have always argued successfully within our ethics system that it would be in practice very hard to anonymise that data, very hard or nearly impossible.”* SA3 (business and management studies).

6.5.2. Types of research data and perceptions of research data

The survey revealed that of those researchers who had made research data openly available, databases (38%) and experimental results (34%) were the most commonly produced types of data; it was not possible to produce statistically significant results showing disciplinary differences, owing to the low number of responses. In the interviews, however, it was possible to construct a typology (as shown in Fig 5-8) that categorised the research data typically produced into researchers’ specific disciplinary groups, i.e. hard/pure, soft/pure, hard/applied, soft/applied and interdisciplinary. The typology shows that researchers were producing data ranging from interview transcripts, to software code, bio-sample data, building designs etc. and that whilst interview transcripts and survey data were produced by mostly those researchers in Soft (as opposed to Hard) disciplines, some types of data straddled both Hard and Soft disciplines e.g. experimental data, which was produced by scholars in physics and design. There was also some evidence confirming Borgman’s (2008, p.31) assertion that even within disciplines, types of data vary widely; one example is how two historians’ views of what was ‘research data’ differed. While one historian stated that the term ‘research data’ was not a term they used in humanities, the other historian did not seem to share the same view and pointed to audio recordings, databases and interview transcripts as the data that she typically produced.

6.5.3. Realised benefits from sharing/using openly available data

One of the objectives of the research was to uncover what realised benefits (if any), sharing/using research data had on researchers. The most common benefit realised by 59% of survey respondents as a result of making their research data openly available was collaboration opportunities with other researchers within the respondents' disciplines, whilst 30% stated that it led to opportunities for collaboration with researchers outside their discipline. This empirically confirms the 'potential benefits' of sharing data suggested by Borgman (2007) and RIN (2008) and agrees with Borgman's (2007, p.30) suggestion that data acts as a 'glue' for collaborative research i.e. scholars working together to generate data and those data being an essential product of the collaboration. Survey respondents were also asked what impact (if any) had been realised from using openly available research data, 70% of those who had used openly available data stated that it had increased the evidence base of their research, whilst 63% stated that it had reduced the time required for data acquisition. This mirrors the findings of Collins (2011, pp.26-27) who also found an 'increase in evidence base' as the most common 'research practice benefit', and a reduction in time required for data acquisition as the most common 'research efficiency benefit' of using openly available data.

The interviews, however, revealed that while most researchers articulated with ease the benefits they realised as a result of *using* openly available data, the same could not be said for the benefits realised as result of *sharing* research data. Certainly, for those researchers who had shared their data, the motivation for sharing mostly hinged on the expectation that they would benefit from doing so, for example through collaborative opportunities with the data user, implying that the notion of sharing research data was based on personal benefit, rather than the research community benefit. This counters RIN (2008) and Youngseek & Stanton (2012) who noted altruism as one of the motivations for sharing data; Youngseek & Stanton (2012, p.52) for example, found researchers to have a "strong desire" to help their colleagues in saving time collecting data, this did not transpire from the interviews.

6.6. Use of social media

This section discusses the role of social media in research dissemination. The survey sought to quantify how many academics were using social media and which social media tools they were using to raise awareness of their research. The interviews examined researcher attitudes towards use of social media and also identified the different purposes for which researchers were using social media.

6.6.1. Using social media to raise awareness of research

The survey found that 39.6% of respondents were using 'general social networking sites' (such as Twitter and Facebook) and 26.5% were using 'academic social networking sites' (such as Researchgate and Mendeley) to raise awareness of their research. These two types of social media tools were the most commonly used by respondents in the survey, implying that the majority of respondents were not using any form social media to raise awareness of their research. The interviews supported this and showed that only a quarter of the twenty-four interviewees were using social media to raise awareness of their research.

The fact that the survey revealed higher usage of general social networking sites (39.6%) than academic-oriented sites (26.5%) is aligned with findings by Jamali *et al.* (2014, p.618) who also found that researchers were using platforms like Facebook and Twitter rather than academic-oriented ones such as Mendeley. In addition, Gerwin (2010, p.993) talks of how academics are "indifferent" towards the use of academic-oriented social networking sites, while Huggett (2010, p.6) states that academic social networking sites had failed to "capture the interest" of researchers. In the interviews, there was no strong evidence pointing to why researchers preferred using general social networking sites to academic-oriented sites, two researchers however stated that because they already owned accounts on general social networking sites which they were already using in their personal lives, they had extended to use them in their professional lives as well.

6.6.2. Other uses of social media

Academics were not only using social media to raise awareness of their research within the academic community, but also to engage with the public. The survey revealed that researchers were making efforts to engage the public with their research through using social networking sites (31%), blogs (25%) and podcasts (9%). In comparison, other studies have shown that 10% of researchers were 'interacting online with the public' (Davies, 2013) and 5% of respondents were using blogs and podcasts (Abreau *et al.,* 2009). The fact that the majority of researchers were not using social media to engage the public suggests that some researchers are still unsure of its effectiveness in disseminating research; one interviewee pointed to how she was not certain who "in the public sphere" read her blog posts regarding her research and what difference the posts made. In recent years, 'altmetrics' have been developed, which quantify blog posts, 'tweets', 'likes', mentions etc. on social media and other online platforms and so measure the online coverage of scholarly material, but awareness of these tools is still low - certainly from the twenty-four researchers interviewed in this sample, only two were aware of such tools.

Another use of social media revealed by the interviews was how some academics were using (particularly academic-oriented) social media as a substitute for institutional repositories. The reasons for doing this were varied; for example, one researcher stated he was unaware that his university had an institutional repository therefore uploaded his work on Academia.edu. Another example involved a researcher who simply did not "bother" with institutional repositories thus uploaded his journal papers on Academia.edu and Researchgate. This was an unexpected finding as there was no such evidence in the reviewed literature (e.g. Jamali et al. 2014; Holmberg & Thelwall, 2014; Nicholas & Rowlands, 2011) of social media being used as substitute for institutional repositories, particularly when universities and funding bodies have introduced policies mandating scholarly work to be uploaded on institutional repositories, and some publishers have copyright policies that exclude uploading papers on social networking sites.

6.6.3. Reasons for use/non-use of social media.

There is evidence from previous studies (Proctor *et al*., 2010; Nicholas & Rowlands, 2011; Jamali *et al*., 2014) of 'lack of time' (due to teaching loads, administrative duties and other academic activities) being a crucial barrier to some researchers not using social media. Surprisingly, although this study identified some evidence of this (three out of the twenty-four interviewees stated time being a barrier) it was hesitancy towards using technology, generational differences and the 'appropriateness' of using social media to disseminate research in the different disciplines that were the key factors with regards to whether researchers used social media or not.

Evidence from the survey showed that statistically there was a general trend of higher use of general social networking sites being in the 0-17 years of research experience range than in the 18 years or more range - implying that less experienced researchers were more receptive to using social media than more experienced researchers. The interviews, however, revealed a more complex picture. The interviews revealed that non-use of social media was due to *both* hesitancy of using technology, regardless of how experienced the researcher was, and also hesitancy to use technology due to generational differences, as one researcher stated; *"I'm afraid that's a generational thing"; and another – "I'm at the end of my career, therefore maybe less tech-savvy than others".* Other studies (RIN, 2008; Jamali *et al.* 2014) however, have compared social media use based on respondents' age (this study used respondents' years of research experience) and found there to be a weak link between the age categories and use of social media. Certainly, in this study, whilst age categories were not used to gather data (therefore not allowing direct comparisons with the studies above), data from the interviews revealed that in the main, more experienced researchers were non-users of social media due to generational differences, hence being more hesitant to adopt the technology than less experienced researchers.

The other factor influencing social media use was 'appropriateness', which is captured in the discussion about disciplinary differences in sub-section 6.6.3.1 below.

6.6.3.1. Disciplinary differences in social media use

Survey results revealed that although there were no disciplinary differences in the use of academic-oriented social networking sites, there were however disciplinary differences when looking at general social networking sites (e.g. Facebook and Twitter) and mailing lists (e.g. JISC mail), whereby a greater proportion of respondents in the Soft and Interdisciplinary compared to Hard disciplines were using social media to raise awareness of their research (there were no differences when comparing Pure with Applied disciplines). The interviews also supported this notion, with some researchers in Hard disciplines questioning whether social media was an "appropriate platform" and others describing their research communities as "conservative"; in comparison, there were comments such as "very digitally engaged" and "using social media are the sort of things that we do" from some of the researchers in Soft disciplines. The reason why researchers in Hard disciplines questioned the appropriateness of social media can be attributed to how traditional channels such as the peer-reviewed journal are deemed of paramount importance in disseminating research as opposed to non-traditional platforms such as social media.

The findings above contrast with other studies (RIN, 2010; Holmberg & Thelwall, 2014) that have found social media use to be more prevalent in Hard compared to Soft disciplines. Holmberg & Thelwall's (2014) study looked at disciplinary differences in the use of a particular general social networking tool – Twitter. Holmberg & Thelwall (2014, p.1035) found that there was a higher prevalence of Twitter usage (23.5% and 23% respectively) by academics in chemo-informatics and astrophysics, (both 'hard' disciplines) compared to economics (6.5%) and sociology (0.5%) (both 'soft' disciplines). Other disciplines considered in the study straddling both hard and soft boundaries were digital humanities and social network analysis which had Twitter usage rates of 22% and 8.5% respectively. In addition, RIN's (2008, p.58) study focused on a wider range of social media tools (both general and academic-oriented) and found that more academics in 'computer science and mathematics' (76%) compared to those in 'economics and social sciences' (55%) and 'arts and humanities' (55%) had made frequent or occasional use of social media.

6.7. Public Engagement

The section looks at one of the research dissemination mechanisms – public engagement. The questionnaire sought to gather information on the number of researchers that were taking part in public engagement, the types of public engagement activities they had undertaken and the audience groups they deemed important. The interviewees on the other hand served the purpose of getting insight into the attitudes of researchers towards public engagement and their experiences of taking part in it.

6.7.1. Participation in public engagement activities

Seventy-nine percent of the questionnaire respondents indicated that they had undertaken some form of public engagement activity with their research over the past five years. This is broadly in line with other related studies – 74% of researchers (Royal Society, 2006) and 68% (Davies, 2013) which have also shown that the majority of researchers had taken part in some form of public engagement activity**.** The survey also revealed that the most common reason why respondents were motivated to take part in public engagement was as a way of 'increasing the impact of their work' (72%), with statements such as 'changing the world' and 'changing behaviours' noted. The fact that the majority of researchers were taking part in public engagement and that their main motivator for doing so was facilitating the impact of their work suggests that researchers, in the main, recognise the importance and potential opportunities of engaging with the public. This is against the backdrop of recent shifts in UK higher education policy such as the introduction of broader impact into research evaluation. The second most common motivator for taking part in public engagement, 'to inspire leaning' (69%) however, shows that despite the broader impact agenda, academics still feel the responsibility of keeping the public informed, which was the key objective of public engagement as spelled out by the seminal *Bodmer Report* (1985) and other later initiatives such as the House of Lords Science and Technology Committee (2000) which spelled out the need for Research Councils to play a role in promoting public engagement.

The survey also showed that as researchers become more experienced, they are more likely to take part in public engagement activities; this was confirmed in the interviews by one of the researchers (SA3, business and management studies) who had less than 5 years research experience and stated that it was only "senior people" that are invited to present at university-hosted lecture presentations to business practitioners. In contrast, another interviewee, SA4, in the same discipline as SA3 but with more research experience explained that her 20 years of research experience had allowed her to establish extensive networks, both practitioners and policy-makers in her field of employment policy, some of whom had invited her to present her research at annual events. This contrasts with Davies (2013, p.731) who found no relationship between research experience and participation in public engagement. Another study (Abreau *et al*. 2011, p.12) nevertheless found that public engagement activity increased notably with age. Direct comparisons cannot be made however, due to the possibility of older researchers having less research experience than young researchers, perhaps due to joining the academic profession later on in their lives.

6.7.1.2. Types of public engagement activity

The following statement by RCUK (n.d.) was used to define public engagement as: "*any activity that engages the public with research, from science communication in science centres or festivals, to consultation, to public dialogue.*" The survey revealed that researchers were taking part in a range of public engagement activities, the most common being 'presented to a professional audience' (73%) followed by 'presented a public lecture' (60%). Note that although the survey showed that researchers were using both traditional and social media to engage the public with their research; only traditional media is discussed in this section as social media was discussed in 6.6. With regards to traditional media, academics were using channels such as radio and TV (32%) and newspapers/magazines (41%) to engage the public. There was evidence from the interviews of some academics using the services of public relations firms to help in disseminating their research in traditional media outlets such as newspapers and magazines. This was an unexpected finding as previous studies have pointed to researchers mainly using their personal contacts in organisations (D'Este & Perkmann, 2011), or in-house marketing offices or technology transfer offices (Abreau *et al.* 2009), in order to facilitate dissemination of their research. Seeking outside expertise such as public relations firms suggests that researchers are looking for ways to have their research having as wide a reach as possible to their intended audiences, with the hope that ultimately their research will be used by these audiences.

6.7.2. Relevant audiences for engagement

The survey and interviews revealed that researchers in different disciplinary groups viewed some audiences as more important to engage with than others. There was evidence from the survey that, whereas respondents in Applied and Both Dimensions discipline groups viewed *Industry*, *Professional Organisations* and *Government Departments* as relevant audiences, but when it came to the *General Public*, it was respondents from Pure and Both Dimensions discipline groups who viewed them as more relevant. This suggests that, while academics from Pure disciplines are happy to engage with the *General Public*, for academics in Applied disciplines, because of the importance of external sources of influence on their research and a higher degree of concern for application to practical problems as characterised by Biglan (1973a,b), engaging with specific groups such as *Industry* and *Professional Organisations* is important to them. Such engagement potentially allows academics to gain insights into their own research area (Abreu *et al*., 2009, p.35) and also gives an opportunity for access to funds and other resources in future (D'Este & Perkmann, 2011, p.330).

With regards to the Hard-Soft comparison, only two audience groups – *Schools* and *Industry* showed an association with the Hard v Soft disciplinary groups. In both instances, a greater proportion of respondents from the Hard and Both Dimensions discipline groups viewed *Industry* and *Schools* as relevant audiences than in the Soft discipline group. There was some evidence of this in the *REF2014 Panel Overview Reports* that hard disciplines such as physics for example, had led to an increase in the number of children studying physics over the past few years due to the “outstanding outreach activity” which was reflected in the REF submissions (HEFCE, 2015b, p.38).

The interviews in his study, however, revealed that some academics (including those in Hard disciplines) felt they were being pressured by their institution to engage with Schools particularly, even though some of the academics did not view Schools as a relevant audience. One of the interviewees stated that he felt the reason was for his institution “to increase its profile and probably attracting more students in this competitive environment". Watermeyer (2012, p.398) also noted how some academics perceived their institutions to view public engagement as a ‘public relations campaign’ rather than as an activity of learning and sharing knowledge with audience groups.

Related to the above was a key finding on academic attitudes towards institutional influence on public engagement. Interviewees, from mostly Pure (as opposed to Applied) disciplines, did not agree with the idea of formalising public engagement as part of appraisal systems; the reasons ranged from some academics being concerned that their research was “too complex” to explain to lay audiences, to some feeling that there was “not much interest” in their research area. For example, SP5 (English literature & history) felt that there was not much interest in her research area, Victorian and Gothic literature, compared to some of her colleagues who specialised in football history which was more contemporary and more popular with the public. This corroborates findings in previous work by Harley *et al*. (2010) and Levitt *et al.* (2010). Harley *et al*. (2010, p.19) noted that opportunities for public engagement also follow the changing interests of the public, as ‘topical’ subjects shift with current events. Levitt *et al.* (2010, p.22) confirms this and notes the role of fashions and trends in ‘shaping’ public interest in academic research, particularly that in the arts and humanities.

6.8. Articulating ‘research impact’ and perceptions of the REF

This final section of the chapter discusses how the phrase 'research impact' is articulated by researchers in different disciplinary groups and the ways in which the REF 2014 is perceived as a research evaluation mechanism. Whereas previous sections in this chapter integrated data from both the questionnaire and the interviews, this section draws data mainly from the interviews, as the nature of the questions, as described in Chapter Three, lend themselves more to qualitative rather than quantitative enquiry. The section first discusses researchers' articulation of what 'research impact' means to them, then moves on to their efforts in influencing stakeholders such as policymakers and practitioners, and lastly discusses interviewees' attitudes towards the REF 2014 as a research evaluation mechanism including researchers' awareness of how socio-economic impact might be measured.

6.8.1. Articulating 'research impact'

Interviewees were asked what the phrase 'research impact' meant to them, and responses ranged from abstract concepts such as 'changing people's minds' to tangible concepts such as 'producing a product'. As detailed in section 5.8 the responses were categorised into conceptual, instrumental, capacity-building, citation of papers and advancing the discipline. Conceptual, instrumental and capacity-building are defined by ESRC (n.d.) as:

- *Conceptual*: contributing to the understanding of policy issues, reframing debates
- *Instrumental*: influencing the development of policy, practice or service provision, shaping legislation, altering behaviour
- *Capacity building*: through technical and personal skill development.

The interviews showed that only those interviewees from Hard disciplines (particularly hard pure) were keen to emphasise academic impact through citations of papers and 'advancing the discipline' as part of their definition of 'research impact', suggesting that non-academic audiences were less important than their peers in the academic community. This was also reflected in the assessment of research outputs for the REF2014. A review of the REF2014 overview panel reports showed that Main Panel A and Main Panel B, which both consist of hard disciplines such as biological sciences and chemistry used citation data as a "valuable additional tool" for informing peer review (HEFCE, 2015a, p.8)

Other researchers' definitions of research impact however, mainly focused on socio-economic impact, and their responses ranged from defining impact through abstract concepts such as 'changing people's minds' (conceptual) to tangible concepts such as 'producing a product' (instrumental). These are discussed in more detail below in the context of impact on policymakers and impact on practitioners.

6.8.1.1. Impact on policymakers

Most interviewees who described research impact as referring to abstract concepts such as 'changing people's minds' were keen to talk about how their research had influenced policy. These interviewees, particularly from Interdisciplinary and Soft (as opposed to Hard) disciplines explained their efforts in interacting with policymakers ranging from officials in local authorities, to Members of Parliament and national governments. In a related study, Upton, Goddard & Valance (2014, p.356) found that 'informing public policy' was rated highly particularly by researchers in social sciences, planning, law and economics (all of which can generally be considered as 'soft' disciplines), compared to other broad disciplinary groups. Moreover, Watermeyer (2014, p.364) found that of all the stakeholder interactions undertaken by social scientists, gaining the attention of policymakers, was considered very important social scientists. Also, in a recent study involving text mining of case studies submitted for REF2014 by King's College London & Digital Science (2015, p.55), 'parliamentary scrutiny' was found to be most prevalent in Main Panel C (which consists of soft disciplines such as education, law and sociology), compared to the other three panels. The reason why soft disciplines lend themselves more to policy discourse than hard disciplines can be attributed to the distinction of the nature of knowledge between the two. Becher (1987) characterises research in soft disciplines as resulting in 'protocols and procedures' and 'understanding and interpretation' of phenomena, whereas that in hard disciplines mostly focuses on 'discovery/explanation' and ‘products and techniques’ (Becher 1987, p.289). This observation however only serves to give a theoretical account of how research in soft disciplines gravitates more towards policy discourse, and does not make light of the contribution of ‘hard knowledge’ in policymaking. Indeed, there was evidence of two interviewees from the Hard disciplinary group (physics and computer science) who stated that their research was important in influencing policy, one stated how his research in physics had contributed to the national curriculum in secondary schools. In addition, there was evidence in the King’s College London & Digital Science (2015) study of ‘informing government policy’ being mentioned in a number of case studies submitted to Main Panel A and Main Panel B, both consisting of hard disciplines such as biological sciences and chemistry.

The interviews also showed that some researchers believed that ‘politics’ (i.e. disinterest by policymakers of research that challenged government policy) and the prestige of the university at which they were employed were barriers in their efforts in making their work relevant to policymakers. SP1 (politics and international relations) for example, stated that although he sensed that civil servants in the Home Office were interested in his research, policymakers were not interested however as some of his research challenged government policy. Another interviewee SP5 (English literature and history) researcher stated how “the wider encouragement of questioning and thought-processes in the humanities is not always welcome by policymakers” as it challenges received ideas. This brings to light the issue of how research is ‘used’ by policymakers - Upton, Vallance & Goddard (2014, p.362) for example, stress how empirical evidence from research projects can either be ignored for political reasons or how it can be used for *legitimising* decisions rather than *informing* them. Moreover, Belfiore & Bennett (2010, p.122) state that evidence from academic research “is but one of the ‘ingredients’ from which policies are created, and might, in fact, not even be the one of the main ingredients”. Indeed, the *REF2014 Panel Overview Report* on Politics and International Studies (HEFCE, 2015c, p.111) acknowledged the role of factors “beyond the control of researchers” in either amplifying or minimising the impact of policy-related research.

The other issue to arise was the perception that those researchers employed by the more prestigious universities had more clout when trying to engage with policymakers; as one interviewee stated how she had struggled in a "market where 'Oxbridge' academics are the first ones to be listened to". There was the perception that prestigious universities' reputations as leading research universities in the country, plus their traditional associations with policymakers through lobby groups for example, meant that academics from such universities had more opportunities for their research to potentially make an impact on policy. This was an unexpected finding, as from various studies including Belfiore & Bennett (2010); Oliver *et al.* (2014) and Upton, Valance & Goddard (2014) that have looked at the use of academic evidence in policy-making, among the wide range of barriers identified, institutional prestige was not among them.

6.8.1.2. Impact on practitioners

Most interviewees who described research impact as referring to tangible concepts such as 'producing a product' were keen to talk about how their research had influenced practitioners. These interviewees, particularly from Hard (as opposed to Soft) disciplines explained their efforts in interacting with practitioners including opticians, architects and librarians. A possible explanation for these disciplinary differences, as explained above may be due to the epistemological differences between hard and soft disciplines as characterised by Becher (1987). Research in soft disciplines is described by Becher (1987, p.289) as resulting in 'protocols and procedures' and 'understanding and interpretation' of phenomena, whereas that in hard disciplines mostly focuses on 'discovery/explanation' and 'products and techniques'.

Some researchers explained how they had faced challenges in engaging practitioners to use their research. Interviewees attributed this to a range of factors, one of them being a culture of aversion to innovation by public transport providers meaning the researcher felt that her research on sustainable travelling was ignored. Another reason that emerged was poor knowledge sharing practices, particularly in large organisations. Knowledge sharing is defined by Christensen (2007, p.37) as a process of "identifying existing and accessible knowledge, in order to transfer and apply this knowledge to solve specific tasks better, faster and cheaper than they would otherwise have been solved". Hence in this context, the interviewee felt that individuals or teams in organisations were not transferring the knowledge gained from academic research to other teams/departments in the organisation, as this would potentially allow procedures to be executed more efficiently and allow cost savings. In response to such a challenge, the researcher and her project team had formulated research dissemination strategies of targeting internal publications (such as newsletters and magazines) of these organisations. The researcher was aware however, that although there was potential 'reach' of such publications, she was unsure whether those recommendations would be adopted and make an 'impact'

Other challenges faced by interviewees in influencing both practitioners and policymakers can be explored through the concept of the 'impact gap' (Watermeyer 2014, p.370) below.

6.8.1.3. An 'impact gap'?

There were concerns by some interviewees, mostly early-career researchers (i.e. those who had less than five years of research experience) that they found it challenging to initiate or develop professional relationships with stakeholders who would potentially 'use' their research. One example was given by a politics and international relations lecturer with three years research experience who explained that that it was the "*long-standing, well-established relationships*" built between the academic and the research user that "*lend themselves to developing an impact case".* This confirms what Watermeyer (2014, p.370) refers to as the 'impact gap', whereby as a result of limited experience of interacting with non-academic audiences, some early-career researchers face challenges in demonstrating the impact of their research. More experienced researchers in contrast, are more likely to have had the time to cultivate relationships with potential research users over the years. One example is an interviewee who had up to 25 years of research experience and stated that her "career-long" networks had resulted in giving evidence at the Houses of Parliament and also some of her work being published in policy briefings, informing policy on trade unions.

To counter the effects of having few or non-existent networks in firms and government departments, the study revealed how some interviewees stated that they had at times relied on their students (past or present) to introduce them to networks within their (students') organisations. Also, it was mostly the early-career researchers who were formulating dissemination strategies such as using PR firms, and also using social media to engage with relevant audiences. Although these types of research dissemination strategies can be said to lead to 'reach' there was no indication what 'significance' they may have had, as one interviewee with less than 5 years research experience explained that she had tried publishing in magazines and professional journals research that was more tailored to a professional audience, but stated that "I have no idea if people read it. So I don't know if my work has any impact at all." (SA3, business and management studies).

6.8.2. Attitudes towards the REF as a research evaluation mechanism

The interviews revealed different attitudes towards the REF; all four interviewees who stated that they were directly involved in managing departmental/school preparations for the REF had a more positive attitude about the REF in general than other interviewees who were not involved in administering or monitoring submissions. For example, HP4 (computer science) referred to assessment by REF sub-panellists as a "robust" system that checks with research users whether the impact claims were factual and accurate. This confirms findings by Manville (2015, p.68) who noted that academics involved in research impact assessment were more positive about the process than those who were not and held more "equivocal views" regarding the REF.

6.8.2.1. Measuring socio-economic impact

Another issue from the interviews was the consideration of how socio-economic impacts of research might be measured. As stated in section 5.9, most of the interviewees explained that they were not aware of how this might be done; whilst those who stated that they did know, did not seem keen to be drawn on the specific details. Of the twenty-four interviewees, only one interviewee - SP2 (politics and international studies) stated how in his field they used a method called 'most significant change' which is a "democratic evaluation method" (Shah, 2014, p.265) that involves research users, not researchers creating impact indicators, for example reduction in illness and then asked, after the completion of the project – what is/are the most significant change(s) they experienced as a result of the intervention from project?

While interviewees were unable to explain how socio-economic impact might be measured, they were however keen to highlight the challenges in evidencing socio-economic impact, the most common issue raised being attribution. Interviewees' responses confirmed the findings of various other studies including Levitt *et al.* (2010); Shaw & Boaz (2011) and Watermeyer (2014) of the challenges in attributing certain impacts to a particular research project. Conversely, Manville *et al*. (2015) study on the experiences of research users and researchers in preparing impact submissions for REF 2014, found that attribution was not a major concern for researchers; rather it was for research users, some of whom found it challenging relating impact in their organisation specifically to the work of a research project. One of these organisations noted that in a very small number of instances they felt researchers had "overstated their impact" (Manville *et al*., 2015, p.56). It is noteworthy however that this study interviewed researchers directly involved in authoring of impact case studies whose awareness and concerns of attribution of impacts may be different from the rest of those academics who were not involved authoring impact case studies.

6.9. Summary of the Discussion Chapter

The discussion above has brought to light a number of issues with regards to how researchers are disseminating research and their perceptions towards the concept of 'research impact'. Firstly, despite advocacy towards open access and open science in recent years, the study pointed to researchers generally being unaware of the principle of open access, and that researchers in the main, were more articulate about the benefits they had realised from *using* as opposed to *sharing* openly available data. Secondly, in a bid to facilitate the impact of their work, some researchers are finding creative ways of engaging non-academic audiences, through by example, using social media or hiring PR firms to publicise their work in relevant outlets.

Using McNay's (2007, p.539) 'push-pull' analogy of the conflicting goals between academics and academic leaders, this study has shown that there appears to be a *push* by institutions (and their departments/schools) towards encouraging academics to publish in high impact journals, yet there is a *pull* by academics, particularly in Applied (as opposed to Pure) disciplines towards autonomy in selecting those outlets they see most suitable in disseminating their research. Moreover, with regard to public engagement with research, the study has also shown that there appears to be a *push* by some universities encouraging academics to target particular non-academic audiences, whereas, there is *pull* by researchers to engage with those audiences they feel are relevant to their research.

The study has also highlighted how 'research impact' and research evaluation mechanisms such as the REF2014 are perceived by researchers. Researchers have different perceptions of what 'research impact' is, for example, those in Hard (as opposed to Soft) disciplines were more keen to emphasise the academic impact component, as opposed to the socio-economic impact component of 'research impact'. Moreover, researchers in Soft (as opposed to Hard) disciplines more keen to talk about how their research had made an impact on policymakers. Conversely, researchers in Hard (as opposed to Soft) disciplines were more keen to talk about how their research had made an impact on practitioners. The study corroborates previous findings on the existence of an 'impact gap' whereby some early-career researchers felt they were disadvantaged due to their limited networks with non-academic audiences compared to their more experienced colleagues. Moreover, the study revealed that researchers, in the main, were uncertain of how socio-economic impact might be measured, and that those researchers who were involved with administering the REF2014 viewed it more positively than those who were not.

Chapter 7: CONCLUSIONS

7.1. Introduction

This final chapter of the thesis highlights the key findings of the study and their implications on various stakeholders including; research funders, institutions and researchers themselves. Firstly, it highlights the extent to which the three research questions of the study have been met and relates this to the extent to which policy and practices are aligned. The chapter then discusses the limitations of the study, together with exploration of possible avenues for future research, then finally highlights the overall contribution of the thesis to current understanding.

7.2. Research Question 1

What are the types of research outputs produced by researchers in different disciplines, what are the channels used to disseminate them, and who are the types of intended audiences?

1a) What are the number and types of research outputs (e.g. journal articles, conference papers, books, book chapters, performances, programme reports etc.) researchers have produced within the REF period 2008-2013?

1b) What are the channels researchers have used to disseminate these outputs; for example, are they using traditional channels such as journals, or other non-traditional channels such as social media and open access repositories?

1c) What are the types of public engagement activities (e.g. public presentations/demonstrations, media appearances etc.) researchers have undertaken in relation to the dissemination of their research.

7.2.1. Valued research outputs

As stated in section 6.3.1, responses to the survey were not enough to perform valid tests showing whether there was an association between disciplinary groups and the types of outputs produced. It was however possible to identify that the most commonly produced types of outputs were journal articles and conference papers, followed by book chapters, research reports and technical reports; whereas compositions, digital/visual media, physical artefacts, patents, performances were the least commonly produced research outputs.

The interviews on the other hand, were able to identify disciplinary differences in a range of research outputs valued by researchers. The interviews found that monographs, conference papers and book chapters were valued by researchers mostly from Soft disciplines, whilst technical reports were valued by those mostly from Hard disciplines, whereas practitioner journals/magazines, translated books/journals were valued by those mostly from Applied and Interdisciplinary areas. There were no disciplinary differences with regards to how the academic journal was valued by researchers, confirming various studies in the literature, including Harley *et al.* (2010); RIN (2009) and Sparks *et al*. (2005) on the importance placed on the academic journal by the academic community.

The study however uncovered that due to the increased emphasis on 'impact' in research evaluation, conflicting goals between researchers and academic leaders existed. The study found that researchers, particularly from Applied and Interdisciplinary (as opposed to Pure) disciplinary groups felt that research outputs such as practitioner journals, as opposed to highly rated academic journals, were most suitable in targeting and making research more accessible to practitioners. By contrast, there was no such evidence from academics in Pure disciplines. Whereas many studies in the literature including, Watermeyer (2011) and Penfield (2014) had suggested that those from Pure (as opposed to Applied) disciplines would be more disadvantaged by the introduction of impact in research evaluation due to their practice of basic (or blue-skies) research), which in most cases has no immediate purpose for practical application; this study has however shown that some researchers in Applied disciplines also feel disadvantaged by the 'impact agenda'; they feel constrained in producing the research outputs they deem suitable for facilitating impact due to pressures in concentrating on producing papers for highly rated journals. In other words, while researchers are being encouraged to disseminate their research as widely as possible to non-academic audiences; the conflicting pressure to prioritise publishing in highly rated journals for the academic audience remains.

7.2.2. Open access

The study also sought to investigate practices and attitudes towards OA; this was against the background of policies by institutions and research funders either encouraging or mandating OA in recent years, most notably HEFCE's (2014) OA policy which reads;

"To be eligible for submission to the post-2014 REF, authors' journals and conference papers must have been deposited in an institutional or subject repository." (HEFCE, 2014, p.1).

This study found evidence of a lack of awareness of the principle of OA by some researchers across all disciplines, and that more researchers were using personal websites rather than institutional or subject repositories to make their work OA. Also, there was evidence of some academics substituting social media platforms such as Academia.edu and Researchgate for institutional repositories in disseminating their research. It can be concluded that, despite advocacy and policies promoting open access over the last few years, some academics are still either apprehensive or unaware of it. This implies that advocacy at both institutional-level and department/school-level is still required for researchers to have a better understanding of OA, especially now that OA is formally embedded in research assessment as a dissemination channel.

7.2.3. Public engagement

The study found that the majority of researchers were undertaking public engagement with their research. Some researchers, however, spoke of their universities having policies that encouraged them to engage with particular audiences such as schools or renowned consultancy firms at the expense of audiences that they felt were more relevant to them. The study established that some audiences are more relevant to some disciplinary groups than to others. One example is, while researchers in Pure disciplines are happy to engage with the general public, for researchers in Applied disciplines, because of the importance of external sources of influence on their research, and a higher degree of concern for application to practical problems as suggested by Biglan (1973), engaging with specific groups such as industry and professional organisations is important to them.

Moreover, mandating public engagement as part of appraisal systems was widely viewed unfavourably, particularly by researchers from Pure (as opposed to Applied) disciplines. If these two aspects (i.e. autonomy in selection of relevant audiences and formalising public engagement in appraisal systems) are not taken into account by academic leaders, then there is the potential for apathy by some members of the academic community towards the 'culture of change' envisaged by NCCPE (2008) and RCUK (2010). Researchers themselves have a role to play in ensuring their time and resources are deployed effectively towards the specific engagement activities they wish to undertake; indeed, this study concurs with Barnet & Mahony's (2011) suggestion of the need for 'segmenting publics' i.e. the need for researchers to apply the marketing principle of segmentation to help in targeting relevant audiences.

The study also found that some academics are using creative ways of engaging the public with their research, with some using PR firms whilst others are using social media. The hesitancy to use social media by some researchers exposed the need for training, or as simply put by one interviewee: "…let's have some guidance as to how to do this." (HA5, civil and construction engineering). Although the potential 'reach' of social media should be emphasised, a targeted approach to relevant audiences is likely to yield the most desirable results. Most importantly such training should be undertaken voluntarily – this provides a 'best scenario of public engagement' envisaged by Watermeyer (2011, p.406), whereby enthusiasm and aptitude are key.

Social media training should also be extended in enabling researchers (particularly those hesitant in using technological tools) to raise awareness of their research within the academic community; although being mindful of the fact that in some disciplines - as found in this study - researchers, predominantly from Hard (as opposed to Soft) disciplines view social media as an 'inappropriate platform' for raising awareness of their research.

7.3. Research Question 2

What role does sharing/using openly available research data play in achieving research impact in different disciplines? 2a) What are the channels (i.e. personal websites, project websites, journal websites, data repositories, open access repositories etc.) used by researchers to disseminate their data, workflows, software and methods (in other words, research by-products)? 2b) In what ways, and to what extent have these research by-products been re-used? 2c) Has researchers' (re)use of openly available data, workflows, software and methods had impact of, for example, increasing their evidence base, increasing their productivity, or some other impact on research outcomes? 2d) What benefits (if any) have been realised by researchers as a result of sharing research data, workflows, software and methods etc. For example, have they been invited for collaborative work or to present at prestigious conferences, media interviews or public talks?

7.3.1. Dissemination of research data

For reasons owing mainly to lack of time and confidentiality of data, the majority of researchers were not making their research data openly available. Confidentiality was more of a concern to researchers in Soft as opposed to Hard disciplines, as most of the data they produced were interview/focus group transcripts. Moreover, a key finding was that while most researchers articulated with ease the benefits they had realised as a result of *using* openly available data, the same could not be said for the benefits realised as result of *sharing* research data. Using openly research data had allowed some researchers benefits including, reduced time required for data acquisition and increased evidence base of their research. Whereas, the small number of researchers who had made their research data openly, had realised some benefits to their research, including opportunities for collaboration with researchers within their disciplines and invitations to present their research.

The benefits of sharing research data have been either encouraged or mandated by institutions and research funders in recent years, for example RCUK's (2011) policy which states;

> *"Systematic management and sharing of research data has many benefits for the research community and the public. These include reinforcing open, transparent and robust academic enquiry, enabling re-use, and combination of datasets from multiple sources. Further, an increased emphasis on sharing of data has the potential to stimulate new approaches to collection, analysis, validation and management of data." (RCUK, 2011, n.p)*

This study has revealed however, that researchers, in the main, are not sharing their research data, therefore only the few who are doing so are realising the benefits that have been championed by research funders and institutions. This implies researchers may need more research data management training to help identify better ways of anonymising data, so that where possible it can still be published without contravening ethical regulations. Also, such training should centre on advocating the potential benefits of making research data openly available to both the research community and to society as a whole.

7.4. Research Question 3

What are researchers' attitudes towards the current methods and frameworks used for evaluating research impact in their disciplines?

3a) What are the proposed frameworks and methods identified in the literature for evaluating research impact across different disciplines?

3b) What are the methods and frameworks researchers think might be most suitable for capturing the impacts of research in their disciplines?

3c) Are there alternative frameworks and methods that can be used for capturing the impacts of research in different disciplines (as categorised by Becher's (1987) typology of disciplines)?

7.4.1. Frameworks and methods for evaluating research impact

The literature review undertaken for the study identified the different frameworks and methods that have been used to evaluate research impact. Distinctions were made on how such frameworks and methods have been applied in different disciplinary contexts; for example, the Payback Framework (Buxton & Hanney (1994), originally applied in evaluating health care research had been adapted for use in the social sciences (Wooding et al., 2007) and in the arts and humanities (Levitt et al., 2010). It was established that a key distinction between the three frameworks was the use of the term 'benefits' in the Buxton & Hanney (1994) framework, whereas the Levitt *et al*. (2010) and Wooding *et al* (2010) frameworks use the term 'impact'. The reason why this was the case as argued by Wooding *et al*. (2007, p.42) was because in health care research there is a generally accepted understanding of what counts as an improvement to public health, and there are techniques for measuring these, such as 'Quality Adjusted Life Years'. In contrast, in the social sciences, research on the labour market or on living standards for example, there is less consensus on how to assess whether a change is a net improvement – implying that some changes may benefit the employee at the expense of the employer, hence moving away from descriptions based on 'benefits' to one based on 'impacts'.

The literature review also involved critically evaluating the methods used to capture research impact in different disciplinary contexts. One of the methods, econometrics, has been applied in evaluating research involving calculating health gains from medical interventions. While econometrics offer the advantage of consistency as they are independent of people's opinions and bias, as argued by Jones (2011), they are heavily dependent on data, therefore are only effective if the right data collection strategies have been put in place. Other methods such as surveys are useful in collecting large scale data, but have the limitation of painting a broad-brush picture on the impact of research projects. Another method critically evaluated were case studies, which was the method selected for evaluating the broader impact of research submitted for REF2014. It was noted that although case studies offer in-depth information on the impact stemming from a piece of research, as they are often undertaken long after the research has undertaken, this presents challenges in making the causal link between research and impact.

It was however not possible to explore researchers' awareness and attitudes on methods and frameworks for evaluating research impact. As explained in Chapters 5 and 6, only one interviewee was aware of the frameworks used in this discipline (politics and international studies) to evaluate impact. This meant that it was not possible to fulfil Aim 3b) and 3c). Nevertheless, the study revealed researchers' attitudes towards the concept of 'impact' and uncovered the extent to which the policy of introducing 'impact' in research evaluation, together with policies formulated by institutions in response to this 'impact agenda' were aligned with practice.

7.4.2. Aligning policy with practice

The first issue regards the conflicting goals between research leaders and researchers with regards to suitable channels for disseminating research outputs has already been highlighted in section 7.2.1. The second issue that requires highlighting here is that of interdisciplinary research. REF 2014 submission guidelines stressed that all forms of research were to be assessed on a "fair and equal basis" and made reference to interdisciplinary and collaborative research in particular;

"All types of research and all forms of research output across all disciplines shall be assessed on a fair and equal basis... including interdisciplinary and collaborative research, while attaching no greater weight to one form over another." (HEFCE, 2011a, p.4)

Although interdisciplinary collaboration is being actively encouraged at the research funder policy level (as shown in the policy quotation above), at the institutional level, because of structures such as journal ranking lists which have become influential in the selection of outputs for submission for research assessment (Mingers & Willmott, 2013, p.1052), researchers are often under pressure to publish in top-ranked journals on departmental/school lists, this is particularly the case for business and management studies, which as also found by Rafols *et al*. (2012), that such lists have bias against interdisciplinary research. In addition, another related finding is how some academics practising interdisciplinary research felt that their research was being 'pigeonholed' into specific units of assessment that did not wholly represent their work.

This has implications on the possibility of researchers in the long-term feeling discouraged to practice interdisciplinary research thereby jeopardising the benefits that interdisciplinary research brings to academia and the potential impacts to society that may arise from it. This is something that academic leaders ought to take into account if interdisciplinary research, which is encouraged by research funders (as shown by the quote above), is to flourish.

The study also showed that due to the emphasis on 'impact' as a criterion for research evaluation, in some instances an 'impact gap' exists between early-career researchers and their more experienced colleagues. This impact gap implies more experienced researchers have had more time to cultivate professional relationships with non-academic individuals or organisations. Hence, early-career researchers will require more training in helping them identify the potential impacts of their research; and also more training on engaging with non-academic audiences through the various channels available such as radio/TV, practitioner magazines, social media etc. This has the potential of enhancing the ‘reach’ of their research, and allows them to build networks, some of whom may go on to either use their research or facilitate its use by organisations, government etc.

As stated above, the study revealed that the majority of researchers interviewed in this study were either unaware or uncertain of how research impact might be measured. In addition, those researchers closely involved in the administration of REF submissions had a more positive attitude towards the REF than those who were not involved. More clarity and understanding of the concept of ‘research impact’ and how impact might be measured is therefore required at both research-funder and departmental/school-level. This helps in ensuring that not only a select few (i.e. those academics involved in administering REF submissions) are knowledgeable about the concept, but that such knowledge diffuses to the rest of academic community. For early-career researchers in particular, this will be a crucial step and a starting point in potentially closing the impact gap.

7.5. Limitations of the study and avenues for future research

Despite the contributions of the study highlighted above, it carries some limitations - one of them being the potential of non-response bias, whereby only those either interested or having strong views about the topic chose to take part in the study, whilst those who were indifferent may have chosen not to take part. Moreover, whilst the study included researchers from a mix of universities, different disciplines and a wide range of research experience, the sample of 260 survey participants and 24 interviewees limits its generalisability to the whole of the UK’s research-active population.

The other limitation concerns the time-scale; this was a cross-sectional study done over a three-year period, capturing academics research dissemination practices and their attitudes towards ‘impact’ at a particular point in time, i.e. just after the conclusion of REF2014. A longitudinal study focusing on how perception and attitudes change over time, say between two REF cycles, is needed. The study would look at how awareness and attitudes towards 'impact' have changed and how researchers were implementing their research dissemination strategies within the context of the policies of the day. Moreover, one of findings of the study was a low awareness of alternative metrics (altmetrics), a point of enquiry in the future would be how may increased uptake of social media by researchers influence their awareness and attitudes towards altmetrics?

The final limitation concerns the suitability of Becher (1987) typology as an explanatory framework. Section 7.5.1 highlights this, and reflects on the application of disciplinary typologies in general.

7.5.1. Reflection on application of disciplinary typologies

Disciplinary typologies have been applied in the literature in various contexts; some of the examples include, Agnew (2013) who used Becher's (1987) typology to examine how academics think about internationalisation in the context of their respective disciplines, and Del Favero (2005) who used Biglan's (1973) model to investigate academic deans' administrative behaviours. This study used Becher's (1987) typology as an explanatory framework for examining academics' research dissemination practices and their awareness and attitudes towards the concept of 'research impact'. The rationale at the beginning of the PhD process was to use a theoretical framework that aids in explaining disciplinary group differences rather than simplifying the discussion by contrasting broad-disciplinary groups - life sciences, humanities, social sciences etc.

The thirty-six units of assessment used for REF2014 were used in the questionnaire for respondents to identify the 'disciplines' that represented the research they carried out; hence, a 'disciplines-as-research' as opposed to a 'disciplines-as-curriculum' (Berger, 1970) approach was adopted. Section 4.2.1 states the justification for using the 36 REF2014 UoA choice after considering other alternatives for capturing respondents' research area. Still, using the thirty six units of assessment presented a limitation in that the units of assessment represented disciplines in the broadest sense, which are ‘inhabited’ by researchers in different intellectual fields. In which case, it is noteworthy to highlight an observation by Fry (2004) mentioned in 2.3.3.7, that intellectual fields within a single discipline can vary to a great extent, and a given intellectual field may have more in common with an intellectual field in another discipline than its own parent discipline.

The study had examples of contrasting attitudes by researchers in the same disciplinary group, for example, in the soft/pure disciplinary group, while SP5 (English language and literature + history) had reservations in using the word ‘research data’ in her answers, SP3 (history) on the other hand, was certain about what research data meant and gave examples of interview transcripts and the databases she typically produced in her research. On the other hand, there were examples reflecting how disciplinary cultures had some influence on individual behaviour; in such cases the word ‘we’ or phrases like ‘in our community’ were used by researchers to explain their research dissemination behaviour. For example, in the hard/pure disciplinary group, HP2 (physics) and HP4 (computer science and informatics) explained how social media was an inappropriate platform for raising awareness of their research in ‘their’ community. However, there were also examples whereby use/non-use of social media was explained by intrinsic factors such as generational differences and hesitancy to use technology rather than disciplinary cultures alone.

The above examples lead to the discussion on the influences of academic behaviour – an ‘essentialist’ approach, as many disciplinary typologies, including Becher (1987) propose, maintains that certain epistemological and/or social characteristics explain academic behaviour. Essentialism is defined by Sayer (1997, p.456) as “the doctrine that objects have the same properties, which make them one kind of thing rather any other.” A ‘moderate essentialist’ stance however, as explained by Trowler (2014, p.1728) argues that “causality is multiple and the interplay of factors influencing behaviour plays out differently in different contexts.” In other words, reality is more complex, and solely relying on disciplinary epistemological or cultural factors to explain academic behaviour presents an over simplistic account. Therefore, to sum up, while the Becher (1987) typology gave an opportunity to explain some of the phenomena in disciplinary groups for this thesis, it is accepted that the limitations highlighted above, mean that caution should be taken in drawing essentialist conclusions.

7.6. Research contribution

To conclude, this thesis argues that there is still more to learn about what 'impact' means and how it might be measured. The thesis makes an overall contribution to knowledge on a general level by providing more understanding of how researchers have responded to the 'impact agenda'. On a more specific level, the thesis identifies the effect of the impact agenda on academic autonomy, and situates this in different disciplinary contexts. It identifies that it is not only researchers from Pure disciplines who feel disadvantaged by the impact agenda but also those from Interdisciplinary and Applied groups who feel an encroachment on their academic autonomy, particularly in selecting channels to disseminate their research and in selecting the relevant audiences they wish to engage with.

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APPENDICES

Appendix 1: Questionnaire Survey

Loughborough University

Maximising research impact: A cross-disciplinary perspective on how research impacts can be planned and maximised

0% complete

Page 1

Thank you for taking part in this survey.

The purpose of this survey is to make a comparison of research dissemination practices of research active staff from different departments drawn from selected universities.

This survey is part of a wider study focusing on open science and research impact; taking a cross-disciplinary perspective, the aim is to develop an understanding of howresearch impacts can be planned and maximised. The study is undertaken by a Loughborough University PhD student, funded by the Arts & Humanities Research Council (AHRC).

All responses will be strictly confidential. Participants will neither be asked to provide their names nor the name of the department/faculty to which they belong to; the name of their university will be anonymised in the reporting of the results.

The survey will take approximately 15 minutes to complete, and consists of 25 questions divided into the following headings;

Information about youInformation about your research outputsDissemination of research dataPublic engagement activities

The survey allows you to save your responses and complete them at a later date, but please do so before the **CLOSING DATE: Friday 21st February 2014; 19:00hrs**

Information about you

1 Which of the following describes your current job title? (If more than one job title is applicable, please select one that covers the majority of your research time)

Please select ▾

a If you selected Other, please specify:

2 What is your gender?

- Male
- Female
- Prefer not to disclose

3 Approximately how many years have you been research active?

Please select ▾

4 Please state the name of your university.

5 From the drop-down list below, please select the category that most closely describes the research that you carry out.

Please select ▾

a If your research cannot be adequately described by the category selected above, please select up to three other categories that apply Additional Category 1:

Please select ▾

b Additional Category 2:

Please select ▾

c Additional Category 3:

Please select ▾

6 Thinking of your research area(s), please select how frequently you engage in research described by the categories below.

Having trouble with the format of this question? View in tableless mode

	Almost always	Frequently	Occasionally	Never	I don't know
Pure basic research: experimental and theoretical work undertaken to acquire new knowledge without looking for long term benefits other than the advancement of knowledge	○	○	○	○	○
Strategic basic research: experimental and theoretical work undertaken to acquire new knowledge directed into specified broad areas in the expectation of practical discoveries	○	○	○	○	○
Applied research: original work undertaken primarily to acquire new knowledge with a specific application in view	○	○	○	○	○
Experimental development: systematic work, using existing knowledge gained from research or practical experience, which is directed to producing e.g. new materials, products, behaviours, devices; or to improving substantially those already produced or installed	○	○	○	○	○

7 Please indicate how frequently you collaborate with the following groups.

Having trouble with the format of this question? View in tableless mode

	Almost always	Frequently	Ocassionally	Never	Not applicable
Researchers within your research group	○	○	○	○	○
Researchers within your department/faculty but outside your research group	○	○	○	○	○
Researchers within your university but outside your department/faculty	○	○	○	○	○
Researchers from other universities within the UK	○	○	○	○	○
Researchers from other universities outside the UK	○	○	○	○	○

8 Thinking about your research area(s), please rate how important is the influence of your research on the following sectors.

Having trouble with the format of this question? View in tableless mode

	Extremely important	Very important	Slightly important	Not important
Society, culture and creativity	○	○	○	○
Commerce	○	○	○	○
Economy	○	○	○	○
Practitioners and professional services	○	○	○	○
Environment	○	○	○	○
Health and welfare	○	○	○	○
Public policy and law	○	○	○	○
International development	○	○	○	○

9 How frequently do you carry out research that requires external funding?

- Almost always
- Frequently
- Occasionally
- Never

10 This question relates to the influence of research within the academic community. Thinking about your research over the past five years, please select whether any of the following has taken place as a result of your research.

- My research revived an interest in an area that had become dormant
- My research contributed to a change of thinking in an existing area
- My research contributed to the discovery of a new area
- My research has made an incremental contribution to a research area
- None of the above
- Other

a If you selected Other, please specify:

Information about your research outputs

The following questions relate to the research outputs you have produced over the past five years (i.e. between 1 January 2008 and 31 December 2013).

11 From the list below, please select the **types** of research outputs you produced, the approximate total **number** produced, and the corresponding number of outputs that were produced as a result of **collaboration**.

Having trouble with the format of this question? View in tableless mode

	(i) Approximate total number of outputs you produced	(ii) Approximately how many were produced as a result of collaboration?
Books (edited and authored)	Please select	Please select
Book chapters	Please select	Please select
Compositions	Please select	Please select
Conference contributions	Please select	Please select
Digital/Visual media	Please select	Please select
Exhibitions	Please select	Please select
Journal articles	Please select	Please select
Patents	Please select	Please select
Performances	Please select	Please select
Physical artefacts	Please select	Please select
Research reports	Please select	Please select
Technical reports	Please select	Please select
Other	Please select	Please select

12 Please indicate whether you have used any of the following social media tools to raise awareness of your research.

- ☐ General social networking sites e.g. Twitter, Facebook, Google+
- ☐ Academic social networking and bookmarking sites e.g. Mendeley, BibSonomy, Delicious
- ☐ Media and presentation sharing sites e.g. Youtube, Flikr, Slideshare
- ☐ Blogs
- ☐ Mailing lists e.g. JISCmail
- ☐ I have not used any of the above tools to raise awareness of my research
- ☐ Other

a If you selected Other, please specify:

13 Please indicate whether you have used any of the following channels to disseminate your research outputs.

- ☐ Personal/research group websites
- ☐ Subject-based repository e.g. ArXiV, RePeC
- ☐ Institutional repository
- ☐ Funder repository e.g. Europe PMC (formerly UK PubMed Central)
- ☐ Open access journals
- ☐ I have not used any of the above channels to disseminate my research outputs

Dissemination of research data

The following questions relate specifically to the dissemination and potential benefits of sharing or using openly available research data.

Openly available research data is defined here to encompass all the underlying results of research and by-products of research, including workflows,source code, survey responses, experimental results, transcripts, software tools etc. that have been made available anywhere on the internet.

14 Over the past five years, have you made research data openly available anywhere on the internet?

- ○ Yes, research data from one of my research outputs
- ○ Yes, research data from a few of my research outputs
- ○ Yes, research data from several of my research outputs
- ○ No, I have not made research data openly available over the past five years

15 Please indicate if you have made any of the following openly available.

- ☐ I have not made research data openly available
- ☐ Workflows
- ☐ Source code
- ☐ Graphic objects
- ☐ Survey responses
- ☐ Video files
- ☐ Interview transcripts
- ☐ Databases
- ☐ Sound files
- ☐ Pilot study results
- ☐ Software tools
- ☐ Text files
- ☐ Experimental results
- ☐ Field notes
- ☐ Image files
- ☐ Other

a If you selected Other, please specify:

16 Please indicate in which of the following locations have you uploaded your research data.

- ☐ I haven't uploaded my research data
- ☐ Blog/Personal website
- ☐ Project website
- ☐ Journal websites with data sharing mandates
- ☐ Institutional repository
- ☐ Open data repository e.g. Archaeology Data Service, Figshare
- ☐ Other

a If you selected Other, please specify:

16 Please indicate in which of the following locations have you uploaded your research data.

- ☐ I haven't uploaded my research data
- ☐ Blog/Personal website
- ☐ Project website
- ☐ Journal websites with data sharing mandates
- ☐ Institutional repository
- ☐ Open data repository e.g. Archaeology Data Service, Figshare
- ☐ Other

a If you selected Other, please specify:

17 Please indicate to what extent you agree or disagree with the following statements.

Having trouble with the format of this question? View in tableless mode

	Strongly agree	Somewhat agree	Somewhat disagree	Strongly disagree	No opinion
Putting my research data in the public domain may result in it being misinterpreted or misreported	○	○	○	○	○
I may need to use the data in future, so making it openly available too soon may reduce the value of my future research	○	○	○	○	○
I often do not have the time to organise the data and make it openly available	○	○	○	○	○
Most of the data I produce is of a confidential nature therefore cannot be made openly available	○	○	○	○	○
As the creator of the data, I fear that the data may be used without due acknowledgement	○	○	○	○	○

18 This question relates to reseachers as CREATORS of data. Please select whether you have experienced any of the following as a result of making your research data openly available.

- ☐ I have not made research data openly available
- ☐ Invitation to a conference to present your research
- ☐ Opportunity for collaboration with researchers from within your discipline
- ☐ Opportunity for collaboration with researchers outside your discipline
- ☐ Opportunity for collaborating in research with an external body (for example: charities, local government, industry)
- ☐ Provided opportunity for securing funding on a new research project
- ☐ Other

a If you selected Other, please specify:

19 This question relates to researchers as USERS of openly available research data. Please indicate whether you have experienced any of the following as a result of using openly available data.

- ☐ I have not used openly available research data
- ☐ Reduced the time required for data acquisition
- ☐ Reduced the time required for data processing
- ☐ Increased the evidence base of your research
- ☐ Allowed you to develop new research questions in your current specialism
- ☐ Provided a collaboration opportunity with the creator of the data
- ☐ Enabled you to publish more research
- ☐ Allowed you to do research you otherwise wouldn't be able to do
- ☐ Other

a If you selected Other, please specify:

Public engagement activities

Research Councils UK define public engagement of research as any activity that engages the public with research, from science communication in science centres or festivals, to consultation, to public dialogue.

20 Over the past five years, have you undertaken any public engagement activities with your research?

- Yes
- No

a If you answered 'No' could you please state if there were any reasons for not doing so?

21 If you answered 'Yes' to Question 20, please indicate if you have been involved in any of the following activities as a way of communicating your research to audiences outside the academic community.

- Use of social networking sites such as Twitter/Facebook
- Written blogs
- Presented podcasts
- Presented a public lecture
- Took part in a public dialogue/debate
- Presented to a professional audience
- Worked with teachers/schools
- Presented a public exhibition
- Made a public performance
- Made a TV and/or radio appearance
- Wrote for a non-academic publication e.g. magazine, newspaper etc.
- Interviewed by a newspaper/magazine journalist
- Other

a If you selected Other, please specify:

22 In the past five years, what impact has your involvement in public engagement activities had on the research that you do?

- ☐ I have not taken part in any public engagement activity
- ☐ It has led to establishing contacts with people/organisations outside academia for future collaboration opportunities
- ☐ It has led to collaboration opportunities with people/organisations outside academia
- ☐ It has strengthened my reputation in the field
- ☐ It has given me new insights for my work
- ☐ It has had very little or no impact
- ☐ I don't know
- ☐ Other

a If you selected Other, please specify:

23 Please rate how important the following factors are with regards to motivating you to undertake any public engagement activity.

Having trouble with the format of this question? View in tableless mode

	Extremely important	Very important	Slightly important	Not important	Not applicable
To be accountable and transparent	○	○	○	○	○
To inspire learning	○	○	○	○	○
To enhance my career	○	○	○	○	○
To win support for my research area	○	○	○	○	○
To influence policy decisions	○	○	○	○	○
To increase the impact of my work	○	○	○	○	○

24 If there are any other factors that motivate you to undertake any public engagement activity, please list them below.

25 Please rate the following groups with regards to their importance as relevant audiences for engaging with your research.

Having trouble with the format of this question? View in tableless mode

	Extremely important	Very important	Slightly important	Not important
Schools	○	○	○	○
Charities	○	○	○	○
Industry	○	○	○	○
Professional organisations	○	○	○	○
Policy institutes (also known as think-tanks)	○	○	○	○
Political parties	○	○	○	○
Local government	○	○	○	○
Government departments	○	○	○	○
The general public	○	○	○	○
Supranational bodies e.g. European Union	○	○	○	○
International bodies e.g. United Nations	○	○	○	○

Thank you.

Thank you very much for taking part in this survey.

26 Please use the space below if you any comments regarding any of the questions in this survey.

27 The next phase of the study involves interviews. Some of the interview questions you will be asked are related to your experience in planning and maximising the impacts of your research, and your attitudes towards research evaluation mechanisms.These interviews are planned to be held between the beginning of March and end of May 2014. Would you be interested in taking part in an interview?

- Yes
- No

27.a If you answered yes, please type your email below, so you can be contacted for further details. Thank you.

Appendix 2: Interview Schedule

Date .... Name/University/Discipline/Research experience ....

Start time ………………… End time ……………..

Venue …..……………………

Introductory statement: thanking the interviewee for their participation; explaining the purpose of the interview; double-checking if they have read the participation information sheet and reiterating important points such as permission to record the interview and how the data will be handled; and finally, explaining how the interview is structured.

1. Description of research area

1i) I have had a look at your university profile and noted that you are in involved in research in.... So, just to have some context could you please briefly explain what this entails?

2. Research practices

2i) Thank you, I have also noted that you have been involved in some collaborative activities, and I am curious to know, with your collaborations over the past five years;

- *check which groups of collaborators; researchers - within discipline, researchers in other disciplines, international or local; or non-academic collaborators*
- On a general level, how did you form those relationships with them?
- What benefits have you realised from these collaborations has this collaboration led to other projects? Were they funded?
    - *check funding opportunities, introduction to new audiences, getting more research published)*

2ii) What would you say are the most important types of research outputs in *your field*; and what are the most important *to you*?

- Why are they important?
- What channels do you use to disseminate these outputs?
  - *check traditional channels e.g. conferences – do they typically consist of pre-dominantly academic, or professional audiences, or both?*
  - *and non-traditional channels e.g. repositories, social media – blogs, social networking sites, listserv groups (mailing lists) etc.*

2iii) In relation to this issue of dissemination of research, one of the topics of interest is the issue of open access to research outputs. Are you aware of any policies - these could be from your faculty/department, university, or research funder(s) - either encouraging you or requiring you to upload your research outputs on repositories?

- What are your thoughts on the principles of open access in relation to the impact of your research?

2iv) In relation to the questions above on social media and repositories, (*check awareness of altmetrics, if not explain to them*) what are your thoughts on the principles of *altmetrics* as a suggested way of measuring the impacts of research outputs?

Thank you for some interesting insight into the collaborative activities, research outputs and channels you use to disseminate them. Another point of enquiry is the issue of sharing or using of openly available research data:

3. Sharing and use of openly available research data

3i) What types of research data is typically produced in your area of research?

3ii) Have you made any of that research data openly available anywhere on the internet over the past five years?

- If no, were there any reasons for not doing so? (*check the following attitudes towards data sharing from survey):*
  - *Putting my research data in the public domain may result in it being misinterpreted or misreported*
  - *I may need to use the data in future, so making it openly available too soon may reduce the value of my future research*
  - *I often do not have the time to organise the data and make it openly available*

- *Most of the data I produce is of a confidential nature therefore cannot be made openly available*
- *As the creator of the data, I fear that the data may be used without due acknowledgement*
- PLUS check from Stoltzfus *et al.* (2012):
- *lack of awareness of policies and options of making it openly available*
- *poor and undocumented submission interfaces*

* If yes. what type of data was this? *(check generic data e.g. databases, text files etc. or discipline-specific data)*
* What motivated you to do so? *(check funding requirements, requests from other researchers? etc.)*
* In which locations did you make it available (is it project website, IR, open data repository?
* Why those locations?
* Did you experience any benefits from sharing this data? (check from survey;
    - *opportunity for collaboration with researchers within your discipline*
    - *invitation to conference*
    - *opportunity for collaboration with researchers outside discipline*
    - *opportunity for collaboration in research with external body*
    - *provided opportunity for securing funding on a research project*

3iii) What do you think about mandates (institutional, funder or journal mandates with regards to making your research data openly available?

3iv) Have you used any research data that has been made openly available anywhere on the internet over the past five years?

* If no, were there any reasons for not doing so? (Check barriers from Stoltzfus *et al.* 2012)
    - *data not required for their research*
    - *made requests that were turned down*
    - *difficulty of* discovering/locating *data*
    - *difficulty of accessing and downloading data because access is procedurally restricted*

- *difficulty of accessing and downloading data because access is technologically limited*
- *difficulty of extracting or decoding data because the data are in an unfamiliar format or are formatted incorrectly (so what description (metadata scheme) would you have needed to know to extract or decode that data?*
- *difficulty of using data because there are errors or inconsistencies*
- *potential for intellectual property restrictions is unknown*

- If yes, how did you find out about the data?
- Can you give an example of the type of data you would normally need to use?
- From which location(s) did you get access to such data?
- Did you experience any benefits as a result of using such data? *(check from survey results)*
  - *increased evidence base of research*
  - *reduced time required for data acquisition*
  - *allowed development on new research questions in current specialism*
  - *allowed you to do research you otherwise wouldn't be able to do*
  - *enable to publish more research*
  - *reduced time required for data processing*
  - *provided collaboration opportunity with the creator of the data*

Thank you. Now moving on to the final segment where we discuss this issue of research impact

4. Perception of the term 'research impact' and attitudes towards research evaluation

4i) What is "research impact" to you and what does it encompass, in the context of your research? *(check from interviewees explanation, how much emphasis he/she places on each of the types of research impact: academic impact and socio-economic impact.*

4ii) Who do you consider to be your research users?

- How do you form those relationships and maintain them?

- Are you aware of any differences your research has made to them?
- How do you become aware that your research has made such differences? Over what time period?
- Have you thought about how these impacts might be measured?
- What do you consider are the difficulties in measuring such impacts?
- Is there a better way of measuring?
- In general, what factors do you consider help the realisation of the impacts of your research?
- What factors do you consider hinder such impacts?

4ii) Are you aware of any general stance by your university or department/school with regards to encouraging academics to engage the public with their research?

- have you undertaken any public engagement activities yourself?
- what motivates you to do so?
- how do you plan them?
- are there any barriers you have encountered?
- what benefits have you realised in taking part?
- how do you know how successful an activity has been?

4iii) Finally, to just to hear your thoughts on the evaluation criteria of the REF – 65% top four outputs, 15% research environment and 20% socio-economic impacts, do you have any thoughts with regards to how this criteria is balanced?

- If involved in teaching, what relationship do you see between your research and teaching?
- Where do you see this issue of research evaluation progressing over the next few years, and how would you like it to progress? *(Provide background on a likely development in the next REF as recommended by Sir Andrew Witty, (Chancellor of University of Nottingham) in a HEFCE commissioned report in December 2013, for an increase of the socio-economic criterion to 25%)*

Thank you for your time and for such an insightful and interesting interview, do you have any questions?

Appendix 3: NVivo screenshot of parent and child nodes

Name	Sources	References
Collaborative activities	26	71
Networks	8	13
Research funding	12	19
Conferences	23	37
Important research outputs	8	9
Books and book chapters	12	37
Conference papers	8	12
Journal articles	25	69
Other outputs	8	15
Research reports	2	2
Open access	25	104
Policies	0	0
Funder policies	4	6
School or Department policies	5	18
University policies	10	20
Public engagement	28	88
Publishers	4	6
Research data	1	1
Barriers to sharing	16	41
Challenges of accessing or re-using researc	10	18
Motivations for sharing	6	7
Realised benefits from sharing	3	4
Realised benefits from using	9	13
Sources of data	9	10
Storage location of data	16	29
Types of research data	18	26
Research impact	0	0
Attitudes towards research evaluation mech	20	70
Barriers of impact	16	50
Expectations of the next REF	10	24
Facilitators of impact	11	20
Measurement of impact	23	57
Research users	19	39
Strategies for maximising impact	8	20
Teaching and research	19	36
What is research impact to you	27	97
Social media	21	51
Academic social networking sites	19	47
General social networking sites	13	31