Sustainable innovation policy: Examining the discourse of UK innovation policy

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A B S T R A C T

Innovation can be a key mechanism to address some of society's greatest challenges, or it can contribute to them. There is extensive conceptual academic literature focused on how policy can be used to create more positive societal and environmental impacts through innovation, however, little empirical evidence exists to understand to what extent innovation policy in particular embeds the principles of social and environmental sustainability into its discourse. We begin to address this lack of evidence by using a critical discourse analysis and corpus linguistics approach to explore how UK Innovation Policy embeds the concepts of societal and environmental impact, and how it balances these at times conflicting paradigms into policy documents. We find that although there is some inclusion of key environmental and societal words these are predominately secondary to economic themes, signalling a 'business as usual' approach to innovation policy.

1. Introduction

Innovation is increasingly viewed as essential to address societies' grand challenges such as homelessness, poverty, the mental health crisis and climate change (Hämäläinen, 2015; Zivkovic, 2018; Hall et al., 2018). These are often described as wicked problems which require not only cross policy solutions (Rittel and Webber, 1973) but engagement with the innovation ecosystem. Innovation policy can be a powerful tool to incentivise solutions through new products, services and models (Christensen et al., 2016). Increasingly, literature calls for attention to innovation practices which are responsible, sustainable and consider societal and environmental impact, including social and sustainable innovation (Schillo and Robinson, 2017; Giulani, 2018). Innovation can contribute to inequalities (Coad et al., 2021) and have negative environmental costs (Owen et al., 2013). Rising public awareness, alongside increased pressure from international governing bodies mean that businesses are being encouraged to reduce the detrimental effects of innovation and to explore positive social and environmental outcomes. Consequently, the question of how to pursue the economic goals of innovation while enhancing its potential to contribute to broader social and environmental objectives is a pressing policy challenge (Schillo and Robinson, 2017). But how are these priorities intersecting in the contemporary policy environment? And what do policy priorities in innovation mean for grand challenges and wicked problems? We

identify a research gap around how sustainable innovation (and related concepts) are used in policy circles and begin to address this research gap by providing a much needed empirical exploration.

This paper provides evidence to answer these questions in the UK context and contributes a methodology that can be used in further inquiries on the adoption of sustainable innovation principles into innovation policy. Sustainable innovation principles include consideration of the environment as a stakeholder (Lischinsky, 2015), aim to be responsible to stakeholders beyond the creation of value for owners (Nazarko, 2019), and to create social impact. We explore the interplay of three paradigms (social, environmental, and economic) in innovation policy, and show that all three are present in recent flagship policy documents. However, we question whether invoking sustainability paradigms around grand challenges in innovation policy represents a meaningful shift or whether the language of sustainable innovation obscures 'business as usual' innovation objectives relating primarily to economic growth (Flanagan and Uyarra, 2016).

We use an innovative approach to textual analysis (critical discourse analysis adopting techniques from corpus linguistics) to look for evidence of social, environmental, and economic paradigms and explore the relationships between them in two flagship innovation policy documents. The purpose of our analysis is to go beyond understanding the use of buzzwords and seeks to understand what social, environmental, and economic themes being used tells us about their significance in

policy. We are particularly interested in uncovering embedded assumptions about the relationship between the economic goals of innovation (such as growth, productivity, and prosperity) and social and environmental goals.

Our findings confirm what many have suspected, but never demonstrated empirically: innovation policy in the UK is not strongly influenced by principles of sustainable innovation despite a facade of the 'right words' which conceals a largely 'business as usual' approach to innovation. Such patterns are likely similar in other national contexts and policy domains. We offer a novel method to test these underlying assumptions and highlight that our findings do still offer hope. While sustainable innovation principles have yet to be meaningfully integrated into flagship innovation policy discourse, the presence of these concepts signals policymakers' willingness to engage in this new territory.

Understanding the dynamics of how social and environmental paradigms interact with the economy and the inherent tensions present is paramount, particularly as policymakers struggle with the competing demands of the (green) recovery (Chen et al., 2020; Montgomery and Mazzei, 2021). Improving the outcomes achieved by innovation requires a shift in the systems that support innovation. This article contributes a much-needed empirically grounded critique of current practice in incorporating social and environmental principles into innovation policy and methodology to hold policy makers to account. This is a crucial step in moving research on how innovation policy can encourage more sustainable innovation and how sustainable innovation policy can be created to reflect the idea that the economy works for society (Albertson et al., 2020) from the realm of theory to inform practice. This research agenda is particularly relevant in the context of an increasing turn towards mission-led policy in the UK and beyond, as well as the increasing urgency and wickedness in the challenges faced in society (Reale, 2021).

2. Sustainable innovation policy: competing and conflicting paradigms

First we question, how does innovation, and the economic growth typically associated with it, relate to social wellbeing and environmental sustainability? A growing body of literature sheds a critical light on the centrality of these topics to national economic policies and increasingly proposes alternatives to growth-led innovation. We survey this literature and highlight the tensions inherent in these paradigms before turning to how these play out in public policy.

There is a normative assumption that growth creates positive social outcomes (Kallis et al., 2018). The belief that economic growth would lead to a rise in living standards is aligned with economic theories of trickle-down economics which see any form of growth as societally positive (Stigiliz, 2016). The Financial Crisis of 2008 and the recession which followed led politicians, economists and the general public to question the economic status quo in which growth has been prioritised (Jacobs and Mazzucato, 2016). De Saille et al. (2020, p.15) argue that 'there is a social agreement that growth will lead to social progress' and that 'growing disparities between economic models and lived reality is causing that social agreement to be questioned'. The argument that innovation and economic growth are unquestionably positive for societal wellbeing usually relates to the creation of well-paying jobs (van Oudeheusden, 2020) and an increase in tax revenues for the public sector (Mazzucato et al., 2020). However, as Stigiliz (2016) and Van Oudheusden et al. (2020) highlight, this argument does not hold while GDP grows but real term wages stagnate overall. Furthermore, corporate taxation has been falling and tax avoidance and evasion rising (Mazzucato et al., 2020) meaning that the tax income from growth is not proportionate to profits made by large companies. This has led to new economic models which attempt to redress the imbalance between economic growth, ecological limits and societal wellbeing, such as the wellbeing economy (Roy, 2021).

Critics of concepts such as responsible innovation and green growth have said that although they promote societal impact and sustainability

in innovation they do not challenge the idea that innovation and economic growth are the drivers of societal impact (Diedrich et al., 2011; Hickel and Kallis, 2020). Inclusive growth has been criticised as a buzzword which can create a placebo effect, however is perhaps better than ignoring inequalities altogether (Lee, 2019). This creates a blind spot in policymaking, whereby innovation is assumed to be 'good' and therefore increasing innovation is inherently positive.

Social innovation is an alternative to the traditionally economically centric innovation models. Definitions of social innovation vary, at times reinforcing the status quo of economic dominance by describing an innovation which has any form of impact on social life, however, more radical definitions focus not only on social impact, but also on changes in social relations (Ayob et al., 2016). Despite this broad conceptualisation of social innovation, since the 21st century, more radical definitions related to social impact and changing social relations, have prevailed (Ayob et al., 2016). Social innovation is one type of alternative innovation that moves beyond the 'no detriment' approach (where we seek not to cause negative impact or harm (De Saille, 2015)) towards embedding people back into the heart of innovation (Fougère and Harding, 2012). A second alternative approach is eco-innovation, which again has differing academic and policy definitions (Cheng and Shiu, 2012). Stojčić (2021, p.2) defines eco-innovation as 'as an innovation capable of reducing pollution, improving efficiency of use and sharing of resources and reducing environmental risks'. Caravella and Crespi (2020) provide a taxonomy of eco-innovation which includes four types targets of innovation: pollution reducing, recycling, energy-saving and material reducing. They find that policy tools are positively correlated with all types (Caravella and Crespi, 2020). Greco et al., (2020, p.1) outline an inherent conflict in environmental innovations, suggesting that environmental innovations are 'socially desirable' but economically undesirable for firms, as the return-on-investment is low, meaning that public sector support is required. Eco-innovation and social innovation are rarely discussed together, however Stojčić (2021) notes that firms will only be concerned with the societal benefits of eco-innovation if there are also economic benefits.

The tensions between economic growth and environmental sustainability are well established and two perspectives stand out. One which looks to mitigate climate impacts of growth through radical changes in the way that the economy and society operate (advocates of behavioural change, degrowth or techno-pessimism), and the second which suggests that economic actors will create technological solutions to the current climate crisis (techno-optimists) (Alexander and Rutherford, 2019). Those who are sceptical of technology's ability to address current climate challenges critique eco-innovation arguing that 'end-of-pipe (or add-on) technologies, which have been a common response to curb polluting emissions, merely shift environmental problems' (van der Bergh et al., 2011, p.4). Diedrich et al. (2011) writing about the development of environmental policy and its relationship to innovation in the EU context note that behavioural change has been neglected in favour of technological solutions. Fothergill et al. (2019) note that UK innovation policy emphasises the technological and neglects the social aspects of innovation policy. For those arguing for such actions as degrowth or stagnation, a common critique decries the prioritisation of environmental protection over the wellbeing of people, which puts the people and planet elements of the triple bottom line (Elkington, 1997) into conflict. Economic growth is then associated with jobs, prosperity and quality of life, meaning that stagnation and degrowth could cause harm to society. However, advocates of these approaches argue that quality of life can be achieved with less consumption (Kallis et al., 2012).

Many of these debates have crystallised around sustainability - a term that has found broad purchase in policy discourse (Yeh, 2020). This concept is useful to the extent that it captures ideas of benefit and impact across broad themes. For instance, Brown et al. (1987) understood sustainability from three perspectives: the social, ecological and economic. The social perspective might be concerned with 'the survival and

happiness of the maximum number of people, or the provision of minimum needs to even the poorest groups.' (Brown et al., 1987, p.716). The environmental perspective on sustainability aims for 'the continued productivity and functioning of ecosystems' whereas the economic perspective is concerned with 'the limitations that a sustainable society must place on economic growth' (Brown et al., 1987, p.716–717). Purvis et al. (2019) developed three pillars of sustainability from these concepts. Fig. 1 outlines our definition of the three paradigms of sustainable innovation policy which are the foundations of our analytical approach.

While the concept of sustainability has emerged in broader policy circles, less is known about how it has influenced innovation policy. Innovation policy covers industrial, science and technology and research policy (Edler and Fagerberg, 2017). A connection between sustainability and innovation first emerged 25 years ago (Soete and Arundel, 1995). The field is rich with theoretical insights (Coenen et al., 2015; Fagerberg and Hutschenreiter, 2020) but little empirical evidence exists about how sustainability has been incorporated into innovation policy. Studies on UK innovation policy tend to focus on the economic outcomes of growth (Foreman-Peck, 2013; Payne, 2017). While Mazzucato et al. (2020) advocate a challenge-led innovation approach to grand challenges such as those outlined by the UN Sustainable Development Goals (SDGs), they do not provide an analysis of policy or empirical data to ground their proposed framework. Existing studies on responsible innovation policies chart its emergence in Europe (De Saille, 2015), explore cases of responsible innovation in emerging technologies such as geoengineering (Stilgoe et al., 2013) or are concerned with responsible innovation from universities (Owen et al., 2021). While frameworks for creating sustainable innovation policy have been proposed (Foxon and Pearson, 2008), an overarching framework for how these concepts interlink in policy is a knowledge gap. In short, while the concept of sustainable innovation (and variants) are part of the debate in innovation circles, we know less about how these concepts are applied in policy documents. Our paper addresses this research gap through the application of a novel methodology which can be used to understand discourses of sustainable innovation policy.

A lack of consensus on the meanings of core concepts is part of the problem in engaging in an empirical stocktaking of progress on sustainable innovation policy. For example, sustainable, social, environmental and responsible innovation are often used interchangeably but have subtle differences in definitions. Responsible innovation refers to a process of creating innovations by including stakeholders in consultation during development (De Saille, 2015; van Oudeusden, 2020). The aim of including stakeholders is to align innovations with societal needs and allow for consideration of ethical, social and environmental impacts (De Saille, 2015). It is associated with a sense of stewardship over the future (Owen et al., 2013). Societal acceptance, which is a core motivation for responsible innovation approaches, we argue, is not synonymous with social or societal impact which is central to definitions of

social innovation (Ayob et al., 2016). Societal acceptance of innovation supports market development for an innovation. By contrast, social and societal impact aim to make positive changes for a group of people or wider society, respectively and social innovation moves beyond consultation to coproduction and co-creation of innovations for public good (Faiz Gallouj et al., 2018). Inclusive innovation is used to describe the process and outcomes of creating new products or services (as well as frameworks and guidelines) that reduce inequalities created by innovations (Schillo and Robinson, 2017; George et al., 2012). Inclusive innovations benefit the disenfranchised (George et al., 2012). Sustainable innovations are new products or services which not only create economic value but also have positive social and environmental impacts (Cillo et al., 2019). Sustainable innovations therefore must balance economic, environmental and social goals (Cillo et al., 2019). We have mapped some of these different concepts and their relationship to the sustainability paradigms in Fig. 2.

We propose the following definition of sustainable innovation policy which brings together elements from responsible innovation, eco-innovation, social innovation, inclusive innovation and sustainable innovation:

> A proposed course of action which encourages the creation of new products or services which create positive social and environmental impact as well as generating economic value; sustainable innovation policies should encourage innovators to cocreate alongside stakeholders during development to not only increase social acceptability of the innovation but also to reduce the inequalities created by innovations.

The challenge that we have set in this paper is to explore the degree to which the innovation policy laid out in flagship documents can be described as sustainable using this definition as a guide. This involves understanding how these goals are balanced in innovation policies using the example of two UK innovation policy documents. Based on the survey of the literature presented above, we have developed the following hypotheses about what we are likely to find in this analysis:

H1. . Innovation policy documents assume that economic growth has a positive societal effect.

H2. . In innovation policy documents, economic growth is prioritised over societal and environmental objectives and challenges.

Overall, we expect to see tensions in innovation policy between economic objectives and emerging social and environmental themes reflected in the language used. Exploring these hypotheses requires an approach that allows us to understand both the frequency of terminology used but also how concepts are anchored in the discourse, what the contexts within which they are embedded signify, and how ideas are related to one another. We do this using critical discourse analysis with corpus linguistic approaches, a methodology that allows us to draw inferences about the factors influencing policy directions from the language used in innovation documents. This enables us to go beyond keyword counts to examine assumptions about sustainability and implications for the evolution of sustainable innovation policy. The next section elaborates the methodology and our framework of analysis.

3. Methods

We build on Perren and Sapsed (2013) who argue that language is important in the context of innovation policy as it embeds ideologies and influences the business environment. We extend their work by examining the contents of UK innovation policy for themes related to sustainable innovation policy, looking in particular at the Industrial Strategy (2017) and the Innovation Strategy (2021) taking a critical discourse analysis approach using techniques from corpus linguistics. These two documents are flagship policies within the UK Government related to innovation and are governing documents for the innovation

Economic

Actions, terms, and strategies which promote economic growth
Core concepts: economic growth, gross domestic product, trickle down economics

Social

Actions, terms and strategies which promote social wellbeing
Core concepts: health, happiness, equality, empowerment

Environmental

Actions, terms and strategies which relate to the protection of nature
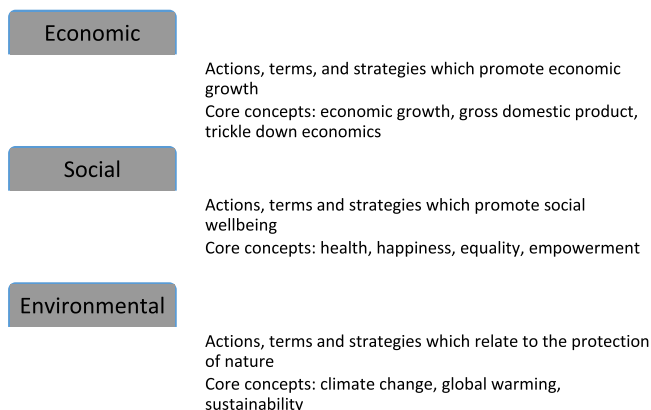Core concepts: climate change, global warming, sustainability

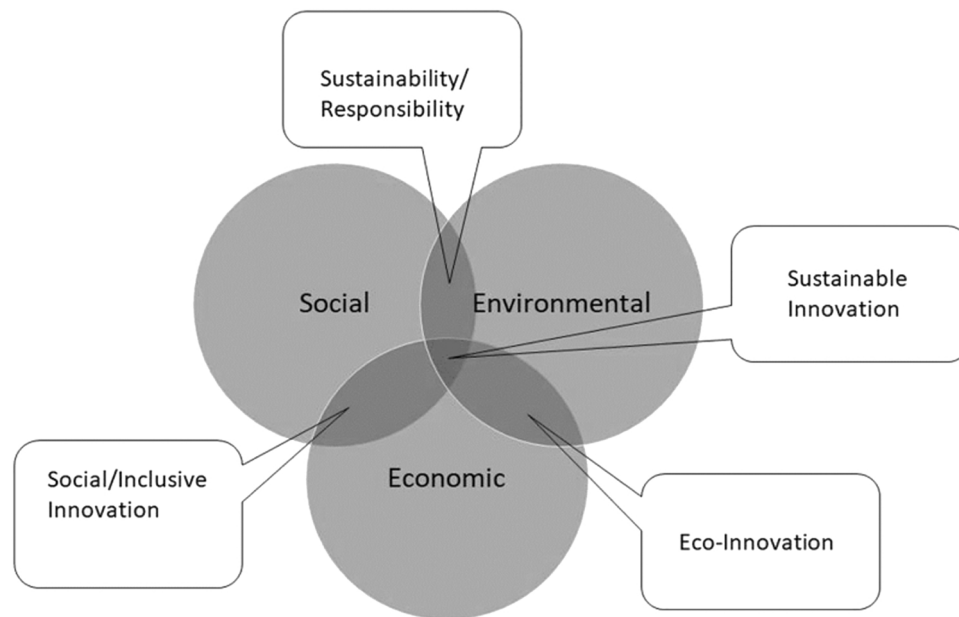**Fig. 1.** Three paradigms of sustainable innovation policy.

Fig. 2. Alternative innovation concepts mapped to sustainability paradigms.

support ecosystems in the UK. Thus they influence much of the discourse around innovation in the UK and shape policy design and implementation across departments. These documents were chosen as they speak to understanding the integration of sustainable innovation in mainstream innovation policy, rather than exploring more niche specific documents we wanted to get a sense of how these concepts are influencing the dominant discourse of innovation policy.

Similar to Fernández-Vázquez and Sancho-Rodríguez (2020), we use critical discourse analysis to understand 'how powerful groups in society control public discourse as a symbolic resource' (p.3). We look to uncover the linguistic characteristics of innovation policy texts and understand how the choices made 'contribute to the persuasive effect the author intends to achieve' (Fernández-Vázquez and Sancho-Rodríguez, 2020, p.3). The language used to describe innovation and the economy helps to shape how it is perceived (Massey, 2013). As Fagerberg and Verspagen (2009) acknowledge, innovation is a word on everybody's lips, and in the policy-making context, there is a pervasive concern with stimulating innovation. Critical discourse analysis acknowledges that language is socially constructed; meaning that the context in which words are used influences their meaning.

3.1. Context of study

Fagerberg (2018) notes that innovation policy is a relatively new term. In UK policy discourse, use of the word 'innovation' has been increasing since the 1960 s and that use has been predominantly positive (Perren and Sapsed, 2013). In 2017, the UK's new Industrial Strategy was launched which was described as heralding the arrival of a more interventionist approach to economic policy (Mason and Walker, 2017) with greater opportunity to steer innovation towards societal and environmental issues. The Industrial Strategy began identifying missions and it featured four grand challenges (artificial intelligence and data, ageing society, clean growth, future of mobility) (UK Government, 2021). Although its title refers to industry, the document was, in fact, conceptualised as a framework for UK innovation policy at the time and was heavily referenced in the initiatives that emerged from the Department for Business, Energy, and Industrial Strategy, funding councils, and other Government departments. At a first glance, some of these challenges appear to address some of the UK's societal and environmental issues (such as healthy ageing and clean growth).

In 2019, a leadership change, followed by a national election

triggered a change in policy. In March 2021, the government announced that the Industrial Strategy would not be renewed, but replaced by an Innovation Strategy (Sunak and Kwarteng, 2021). In July 2021 the UK Government launched their Innovation Policy. Where social and environmental challenges appeared, at least superficially, in the Industrial Strategy, a sustainable innovation agenda was not as immediately evident in the Innovation Strategy. Although policy appeared to have shifted away from flagship social and environmental programmes on the surface, this does not mean that principles of sustainable innovation were not embedded in other ways. Although we compare texts, the timeframe between the publication of each policy is not great enough to trace seismic changes in policy direction. Rather, we explore how both documents discuss sustainable paradigms acknowledging the temporal nature of innovation policy development (Flanagan and Uyarra, 2016).

We focus on the economic, social, and environmental paradigm defined in Fig. 1, building on the work of Brown et al. (1997) and Purvis et al. (2019). We acknowledge that conceptualising these paradigms as completely separate is a simplification of a complex reality and that conceptual overlaps are possible. How we operationalised these concepts to minimise these overlaps is elaborated below.

3.2. Data analysis

Critical discourse analysis and corpus linguistic approaches can be combined to understand policy documents and the use of language within them (see Mason and Moran, 2018 for example). The discourse historical approach to critical discourse analysis used in this research explores issues of power and ideology in text (Reisigl and Wodak, 2016; Prentice, 2010). It is frequently combined with the corpus linguistic approach (Prentice, 2010) which can be described as 'a set of procedures, or methods for studying language' (McEnery and Hardie, 2012, p.1). For the corpus linguistics approach, we used Sketch Engine to facilitate organising and performing basic descriptive statistics on the two policy documents which has been used in similar analytical tasks (for example Fernández-Váquez & Rodríguez (2020) on climate change in large multinationals reporting). Lam et al. (2019) similarly use a corpus linguistic approach to understanding competing demands in policy, media and NGO discourse related to air pollution in Hong Kong. Fig. 3 shows the steps we took to operationalise this approach.

We identified key words and terms using a keyness analysis that enables us to filter words that are significant to our analysis based on
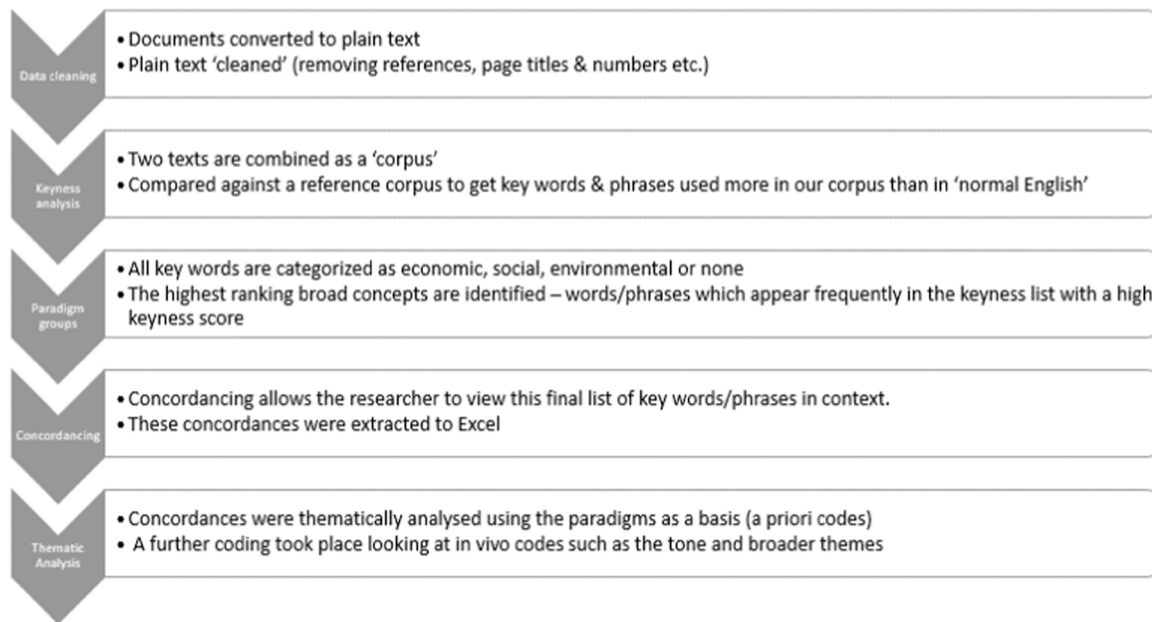
Fig. 3. Overview of Methodological Approach.

how frequently they occur in the target documents versus in normal, written English (as defined by a reference corpus - in this case the En En Ten Ten). This enables us to exclude common words and phrases (such as 'the') and focus on those that are more unique in the target texts.[1] We categorised a full list of keywords and key terms identified by the keyness analysis according to which paradigm they best featured in: economic, social, environmental or none. We then grouped words and phrases identified as key into concepts identifying three central categories which appeared as key in both documents for each of the three paradigms (economic, social and environment). Keywords were chosen with reference to the keyness score, looking to include three broad categories per paradigm according to how high their keyness score was compared to other words or phrases. Tables 1–3 show the focus words chosen for each paradigm alongside the frequency, relative frequency, keyness score and ranking. We categorised innovation as an economic word as it predominantly appeared alongside other economic words (as can be seen in Fig. 4) and sustainable innovation (and similar variants) did not appear as key according to the keyness analysis. In fact, sustainable innovation does not appear in either document, and neither does social innovation or environmental innovation. Eco innovation only appears once. As such we needed to expand the keywords and phrases that represent those ideas.

Although the figures in the tables are suggestive (notably the proportion of economic terms compared to social and environmental terms and the dominance of innovation within the economic paradigm), simple numerical comparison does not allow for a full understanding of the weight and importance of these terms, or how they are used in context. The values do not move beyond purely classifying the terms as 'typical' or 'atypical'. We recognise and acknowledge the ambiguous ways language is used which cannot easily be captured by quantitative methods used in corpus linguistics (McEnery and Wilson, 2001). To take an example from our own dataset, the word 'cleanly' was highlighted by the keyness analysis and initially categorised as an environmental term.

Table 1
Focus terms for economic paradigm with frequency, relative frequency, keyness score.

Economic				
Grouping	Item	Frequency	Relative frequency	Keyness Score
Innovation phrases	innovative business	42	376.9893	313.427
	pro innovation	10	214.4036	215.346
	innovative firm	10	214.4036	213.717
	innovation ecosystem	26	233.3743	210.927
	innovation institution	9	192.9633	193.903
	innovation institution	9	192.9633	193.903
	innovation mission	8	171.5229	172.35
	innovation talent	8	171.5229	172.048
	innovation activity	8	171.5229	169.341
	innovation system	13	116.6872	109.908
	innovative company	13	116.6872	104.856
Innov* words	innovate	91	816.8101	153.072
	innovation	860	7719.305	130.135
	innovator	78	700.123	128.281
	innovative	193	1732.356	42.087
Commercial* words	commercialisation	40	359.0374	207.223
	commercialise	20	179.5187	121.583
Prosper* words	prosperous	11	169.837	33.826
	Prosperity	38	341.0855	31.852

However, looking at the word in context showed that it was referring to 'cleanly separat[ing]' between innovation stages (Innovation Strategy, 2021, p.7) rather than for example cleanly supplying energy.

Concordancing, a corpus linguistics method, allowed us to extract the keywords and phrases and analyse them with a set range of context around it. Concordancing allows a unique view of textual data which facilitates a strong understanding of how the word appears and is changed by the words around it (Mason and Moran, 2018). Looking at the concordances around these keywords, we analysed the data looking at the context to code the data into a series of a priori codes related to each paradigm and combinations of paradigms - Table 4 shows the a priori codes, where the first column is the keyword/phrase paradigm code, and the rows show the context coding. A further coding iteration

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[1] This process is conducted by Sketch Engine based on the following calculation: $\frac{fpm_{rmfocus}+N}{fpm_{rmref}+N}$ Where $fpm_{rmfocus}$ refers to the normalised frequency of a word in the focus corpus and fpm_{rmref} refers to the normalised frequency of the word in the reference corpus and N is the simple Maths parameter (for more details see Kilgarriff et al., 2014)

Table 2
Focus terms for the social paradigm with frequency, relative frequency, keyness score.

Social				
Grouping	**Item**	**Frequency**	**Relative frequency**	**Keyness Score**
Young people	young people	22	197.4706	198.462
Local need	local need	7	62.83155	60.011
Collaboration/ Partnership Phrases	international partner	4	85.76145	81.301
	local partner	4	85.76145	72.395
	innovation collaboration	3	64.32109	65.022
	delivery partner	3	64.32109	61.876
	international collaboration	9	80.78342	59.339
Collab* / Partnership words	partnership	153	1373.318	20.54
	collaboratively	7	62.83155	18.684
	collaboration	89	798.8583	17.121
	consortia	2	17.95187	12.813
	collaborate	22	197.4706	9.428

Table 3
Focus terms for the environmental paradigm with frequency, relative frequency, keyness score.

Environmental				
Grouping	**Item**	**Frequency**	**Relative frequency**	**Keyness Score**
Carbon	low carbon	21	188.4946	96.191
	carbon technology	4	61.75889	61.533
	net zero	7	62.83155	51.561
	carbon emission	6	53.85561	45.419
	low carbon technology	5	44.87968	45.331
	decarbonisation	6	53.85561	42.884
	low carbon energy	2	42.88073	41.342
	carbon energy	2	42.88073	40.422
	decarbonise	1	8.97594	8.124
	low-carbon	1	15.43972	7.776
	carbon	38	341.0855	7.341
Energy/ renewable phrases	fusion energy	4	85.76145	77.814
	energy cost	5	77.19862	60.007
	energy system	4	85.76145	50.013
	energy technology	3	64.32109	48.874
	energy system	9	80.78342	47.143
	offshore wind	11	98.73529	46.917
	floating wind turbine	2	42.88073	43.478
	floating wind	2	42.88073	41.788
	fusion reactor	2	42.88073	39.479
	wind turbine	4	85.76145	37.938
	solar cell	2	42.88073	26.45
Energy/ Renewables words	electrification	6	53.85561	20.663
	offshore	23	206.4465	14.154
	turbine	6	128.6422	10.996
	offshore	7	150.0826	10.309
	decommission	4	35.90374	10.11
	renewable	21	188.4946	8.968
	renewed	2	42.88073	7.016
Sustain* & Clean	sustainably	3	26.92781	10.941
	clean	94	843.7379	7.2

took place to understand thematic and tonal codes related to each paradigm and those which applied cross paradigm. Tonal codes included aspirational, descriptive, example, commitment and priority. Thematic codes included issues such as missions/challenges, technology, heroic innovation, national pride and responsibility. The findings of the qualitative analysis are presented in the following section.
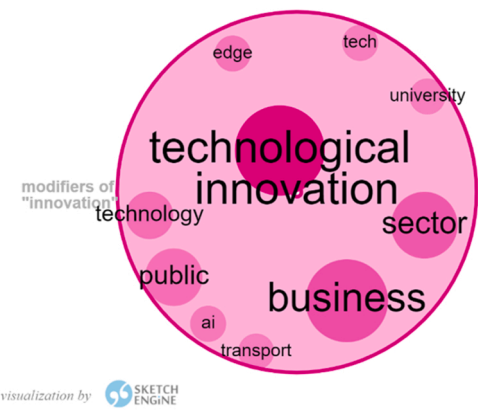

Fig. 4. Word cloud of modifiers of innovation, showing the lack of social and environmental words modifying innovation.

4. Findings

Innovation policy documents have a clear economic imperative by the very nature of their subject matter; however, we seek to empirically explore the underlying embedded assumptions which appear in these economic documents and particularly how ideas are linked to create narratives around sustainability, innovation, and growth. Our particular focus is *on the embedded assumptions made about the relationship between economic growth and societal, and environmental outcomes*. Our first hypothesis related to the implicit assumption that economic growth leads to a positive societal effect.

4.1. Innovation policy documents contain an assumption that economic growth has a positive societal effect

Innovation is depicted as essential to economic growth, which is described as a positive force for society. Statements such as 'Innovation turns great ideas into value, prosperity, productivity and wellbeing' (Innovation Strategy, 2021, p.11) show how societal benefits of innovation such as wellbeing are just items in a list. The order items appear in the list could suggest that this process is sequential, with value, prosperity and productivity leading to wellbeing. However, the final stage, translating value, prosperity and productivity into wellbeing, is the least discussed in our data. This pathway connecting economic growth, through innovation leading to societal benefit is presented without elaboration on how this is achieved or much acknowledgement that this is not always the case. Table 5 provides more examples.

One statement stands out as an exception in our sample:

> We must also recognise there are some communities which have struggled to keep pace with changes in the global economy and as a result not fully shared in the prosperity that growth has delivered (Industrial Strategy, 2017, p.4).

How prosperity is distributed seems important from this passage, however, the underlying inequality caused by the traditional economic systems is not discussed frequently enough to be flagged by the keyness analysis. Rather, broad statements about innovation 'as a force for good around the world, promoting the benefit innovation can bring whilst minimising the scope for its abuse' (Innovation Strategy, 2021, p.35) abound. While mitigation of risk is discussed, little is said about the ways in which this can be achieved or moving beyond 'do no harm' to actively encouraging positive social impact. For innovation policy to be considered sustainable, we suggest that actively encouraging social impact through high-level statements is important.

4.1.1. Innovation saves us all (Heroic Innovation)

The Innovation Strategy (2021) couches the COVID-19 pandemic in

Table 4

Concordance first level coding.

	Economic	Social	Environment
Economic	Economic/Economic	Social/Economic	Environmental/Economic
Social	Economic/Social	Social/Social	Environmental/Social
Environmental	Economic/Environmental	Social/Environmental	Environmental/Environmental
	Triple paradigm		

Table 5

Concordances - Economic and Social cross paradigm, subtheme economic and societal effect.

Document	Left context	Keyword/ term	Right context
Industrial Strategy	ahead – and it is essential if the British people are to enjoy	prosperous	lives with *fulfilling work* and high quality public
Innovation Strategy	our increasing numbers of older people. The challenge is to	innovate	, so *older people's aspirations* are met and so better, more
Innovation Strategy	and *prosperity*. The UK government has therefore placed	innovation	at the heart of its commitments to the British people: ● Our
Innovation Strategy	and export on a global stage. This work will also help de risk	innovation	and position the UK as a *force for good around the world*,
Innovation Strategy	as a force for good around the world, promoting the benefit	innovation	can bring *whilst minimising the scope for its abuse*. This
Innovation Strategy	for deepening international scientific and *commercial*	collaboration	to *benefit people's lives* around the world and for

terms of the power of innovation. The statements in Table 6 demonstrate how innovation was invoked as a panacea for specific public policy challenges but exactly how it contributed is un(der)specified. Framing the COVID-19 pandemic in the past tense rather than in present tense, gives a suggestion we are reflecting on the achievement of curing the pandemic, which at the time of policy's release was still causing thousands of deaths and much disruption in the UK. Furthermore, the innovation framing does not acknowledge social actions which were vital in pandemic resilience.

4.2. Economic themes dominate

Often social and environmental terms are couched in economic frames, or co-opted into economic language. For example, terms which can be discussed as having inherent tensions such as 'clean growth', 'carbon budgets', and 'inclusive growth' where words with either environmental and/or societal connotations are paired with economic words, to transfer some of the positive environmental and/or societal connotations to the economic concept. Rather than integrating these ideas fully, the terms can be critiqued as a process of 'colour washing'(where sustainability statements are made with little genuine engagement with the potential negative social and environmental

Table 6

Innovation saves us all.

Document	Concordance with keyword in italics
Innovation Strategy	'*Innovation* created the path out of the pandemic'
Innovation Strategy	'Yet during this COVID-19 pandemic, our *innovation* ecosystem has come to the rescue'
Innovation Strategy	'The COVID-19 pandemic shows how UK *innovation* can achieve amazing things

impacts) (Garnelo-Gomez, 2022).

4.2.1. Economic & environmental

There is an embedded assumption that development and exploitation of technology will simultaneously lead to more economic growth, and reduce detrimental environmental impacts. Statements such as 'we want to maximise the advantages for UK industry of the global shift to clean growth' (Industrial Strategy, 2017, p.142) and 'The UK's clean economy could grow at four times the rate of GDP' (Industrial Strategy, 2017, p.142) place the emphasis of the environmental challenge firmly in the economic. There is little acknowledgement of the role of growth in environmental issues such as the 'revenge effects' of production of technologies aimed at addressing environmental damage (Hall et al., 2018; Coad et al., 2021).

When looking at the data that was identified as environmental and economic, there was a distinct pattern of commitments made to unlocking investment in clean technologies, as shown in Table 7.

The focus tends to be on technological solutions to environmental challenges, instead of behavioural changes within business or consumers to prevent, change or address climate change (such as circular economy principles). The environmental push is seen as a business opportunity rather than a true engagement with complex environmental problems, or setting goals for positive impact which are likely to increase costs of doing business. Sustainable innovation policy should consider the behavioural aspects of achieving environmental goals alongside technological developments. In our data, commitment to environmental objectives is about investing for business development and technology (e.g. 'We will invest over £2.5bn in low carbon innovation by 2021' (Industrial Strategy, 2017, p.161)). In this theme, statements about the end-of-life of, and of mitigation of impacts of new technologies on the environment could be expected but in the data we examined, did not appear but is important to consider for sustainable innovation policy.

4.2.2. Economic & social

The focus is often on people as secondary to economic concepts, such as in the following quote: 'helping them to seize the opportunities that

Table 7

Concordances in economic and environmental cross paradigm grouping, under keyword 'clean', subtheme of technology.

Document	Left context	keyword/ term	Right context
Industrial Strategy	increase our support for *innovation* so that the costs of	clean	*technologies,* systems and services are reduced across all
Industrial Strategy	Grand Challenge. We will invest in *innovation* to develop	clean	*technologies* across road, rail, aviation and maritime
Industrial Strategy	and development – brings together our commitments to	clean	*growth,* raising *investment in research and development,*
Industrial Strategy	. And we will strengthen support to *commercialise* new	clean	*technologies* through our *investments in patient capital,*
Industrial Strategy	By acting in this way to strengthen the *growth of markets* for	clean	*technologies* in the UK, we will support the development of

the innovation economy will bring' (Innovation Strategy, 2021, p.4) suggesting that the people in this context need help to adapt to the innovation economy, rather than finding ways that the innovation economy can better serve people. Similarly, the ways in which young people are described sees them as parts to be moulded into the needs of the economy. The aspiration to 'help young people develop the skills they need to do the high-paid, high-skilled jobs of the future' (Industrial Strategy, 2017, p.5) put the onus on young people to fit into the jobs of the future, rather than creating jobs of the future which satisfy young people's needs for work that provides a healthy, happy life. Table 7 below highlights the difference in the ways young people are discussed in the Industrial Strategy and the Innovation Strategy. Young people are discussed only in relation to such concepts as 'the world of engineering' and 'businesses' in the Industrial Strategy (2017), whereas the focus in the Innovation Strategy (2021) is more on developing innovation skills and exposure to innovation, see Table 8. However, neither document appears to focus on the young people as determining the sectors for future growth; whereas a sustainable innovation policy approach would put people at the heart of the economy.

The majority of the partnerships and collaborations mentioned discussed business relationships with the aim of creating technology or commercialising knowledge, rather than partnerships with stakeholders for social good. Partnerships were often between business and universities, business and public sector however the third sector (non-profits, charities and social enterprises) only appears in a list a handful of times. Mission partnerships however, were the exception as they were set up to address environmental challenges, see section on environmental and social (see Section 4.3.3).

Some qualification of the potential social issues associated with growth and new technologies could have been expected in this theme; Coad et al. (2021) provide examples such as the cobalt in lithium-ion batteries being linked with corruption, poverty and child labour and digital technologies having inherent discrimination. However, the positivity and optimism surrounding technology and the belief in economic growth as distributing wealth and therefore being socially beneficial remains dominant in our dataset. By focussing on technological advances and ignoring behavioural changes we suggest that there is decoupling from the actors as people who will be affected by societal and environmental issues.

4.3. Putting social and environmental first?

Within the data there were instances where economic themes were not explicitly evident. These fell into the categories of purely environmental, purely social or a mix of social and environmental.

4.3.1. Environmental

The terms identified in the keyness analysis for the environmental paradigm lean towards technological innovation such as the new equipment or technological systems as opposed to behavioural changes (such as reducing, recycling or reusing etc). There is also a focus on energy, the issue of decarbonisation and the idea of 'clean' development. All three of these groups of terms have instances where the surrounding context analysed was exclusively environmental (rather than containing social or economic themes within the context surrounding the term). As with all other categories, much of the text is descriptive; of other policies (such as the Decarbonistion Action Plans or the Net Zero Strategy); of particular energy or heating systems; or of technology which is needed to advance the decarbonisation agenda (see Table 9 for examples). While perhaps technology and system may not be purely economic terms, they speak more of a traditionally economic and techno-optimistic view of addressing climate change.

"Clean" terms appear six times in the Innovation Strategy and 88 times in the Industrial Strategy. Most of these uses are environmental and economic in nature, however four times clean(er) appears in the exclusively environmental paradigm in the Industrial Strategy (2017) and once in the Innovation Strategy (2021). The terms are used within this categorisation, as commitments ('We will develop smart systems for cheap and clean energy across power, heating and transport' Industrial Strategy, 2017, p.45), as describing policy initiatives (e.g. The Clean Maritime Demonstration Competition) and stating the spend to date ('takes the total amount invested in cleaner air since 2010 to £3.2bn.' Industrial Strategy, 2017, p.146). There is also a reference to a 'clean energy revolution' (Industrial Strategy, 2017, p.144) which departs from the factual descriptive representation to a more figurative metaphorical approach typically reserved for the hyperbole around innovation.

Table 8
Concordances - Social + Economic cross paradigm, focus term young people.

Document	Left context	Keyword/term	Right context
Industrial Strategy	what this Industrial Strategy aims to do. It will help	young people	*develop the skills they need to do the high paid, high*
Industrial Strategy	*bring the world of engineering directly to children and*	young people	. It will celebrate the UK's proud engineering heritage and
Industrial Strategy	employers to *increase encounters between businesses* and	young people	and the National Careers Service, to improve the quality
Industrial Strategy	over £ 60 m available to support apprenticeship take up by	young people	and poorer families from disadvantaged areas and setting
Industrial Strategy	audits, monitoring and training will be provided for free,	young people	will have the opportunity to undertake internships and
Innovation Strategy	are several initiatives already running that help give	young people	*exposure to innovation*, they don't currently operate at a
Innovation Strategy	link invention schemes with initiatives that seek to help	young people	develop creative and *entrepreneurial skills* all of which
Innovation Strategy	and test ways to improve and scale up the opportunities that	young people	*have to develop innovation skills and mindsets* from an

Table 9
Sample of Concordances - Environmental paradigm, Descriptive theme, sub-themes policy, systems and tech.

Document	Left context	Keyword/term	Right context
Industrial Strategy	as improve their productivity. This will build on the 2050	Decarbonisation	Action Plans that we have agreed with seven of the most
Industrial Strategy	have called on us to take a whole systems approach to the	decarbonisation	of energy infrastructure systems. We agree with this
Innovation Strategy	and construct systems. Without it we could not connect	renewable	energy systems to our existing grid or shift between
Industrial Strategy	which are developing proposals for a cluster using	carbon	capture, usage and storage. Housing is vital to the
Innovation Strategy	to the world's largest and most sensitive radio telescope,	carbon	capture technologies, a state of the art airborne research
Innovation Strategy	of fuel useful in contexts that are less compatible with	electrification	. We are pioneering hydrogen heating trials, starting with
Industrial Strategy	chains.' A technician trialling a new access system for	offshore	wind turbines on the 7 MW Offshore Renewable Energy
Innovation Strategy	and foundation capable of accommodating the largest	offshore	floating wind turbines with excellent stability even

4.3.2. Social

Words relating to partnerships, collaborations and coalitions are associated with the social paradigm. Although as previously mentioned, many partnerships and collaborations were surrounded by the economic words, the terms related to collaboration and partnership did appear as part of the purely social categorisation of the data. Within these terms, there was a focus on partnerships between governments, in particular, working with the devolved administrations of the UK, whereas in the social/economic categories, partnerships were often described on an intersectoral basis (i.e. between public and private actors).

When discussing young people, the focus in this category was on education and attainment. Interestingly the two documents differed in the context of education and attainment in this category. The Industrial Strategy (2017) discussed increasing the numbers of children gaining high school level education and discussing the opportunities for 'disadvantaged young people' to get into universities. The Innovation Strategy (2021), by contrast, focused on getting young people interested and educated in STEM subjects. While increasing interest in STEM subjects does appear once in this category for the Industrial Strategy (2017), there are no mentions of disadvantaged young people in the Innovation Strategy (2021).

There are only seven references in both texts to local needs, and six of them were classified as relevant only to the social paradigm (with the final being social and economic). Both the Industrial Strategy (2017) and the Innovation Strategy (2021) feature the idea of connecting policymaking to local needs, in the social paradigm. Statements such as 'Policies should therefore match local needs' (Industrial Strategy, 2021, p.217) and 'Being more responsive to local needs is an important part of the government's housing strategy'(Industrial Strategy, 2021, p.233) hint at a level of consultation aligned with a responsible approach to policymaking.

4.3.3. Social + environmental / environmental + social

In both documents there are 12 statements that contain both social and environmental themes. These were often discussed as items in diverse lists, rather than being substantially discussed or related to each other (see Table 10).

Another theme for this data is the discussion of the Mission Innovation initiative which is described as 'a global partnership for clean energy research and development' (Industrial Strategy, 2017, p.43). The discussion of this partnership is descriptive, as it again is used as an example often appearing after 'such as'. This, alongside the lists in Table 11 show how social and environmental paradigms are secondary, and examples, rather than concepts to be discussed in their own right which suggests a lower level of importance in these documents. A third key theme in this data was the sense of responsibility when looking at clean growth and change in energy systems.

The first entry in Table 11 has an aspirational tone, and provides a commitment to 'work to create a future where our cities benefit from cleaner air' (Industrial Strategy, 2017, p.43). However, the end of the sentence brings the economic paradigm in 'our businesses from enhanced resource security and our countryside from regenerated

Table 10
Concordances - social and environmental cross paradigm, subtheme lists.

Document	Left context	keyword/ term	Right context
Innovation Strategy	, from fighting coronavirus (COVID 19) to achieving	net zero	and building Global Britain. Boosting innovation in the economy.Table 1: British Business Bank Programmes
Innovation Strategy	, develop new medicines, and support the UK transition to a	net zero	
Innovation Strategy	as improving human health, caring for our environment, and	sustainably	feeding global populations. Genomics is the study of an

Table 11
Concordances - Environmental and social cross paradigm, subtheme responsibility.

Document	Left context	Keyword/ term	Right context
Industrial Strategy	and energy. We also want *everyone to feel the benefits* of	clean	growth, so we will work to create a future where our cities
Industrial Strategy	*where they live and work, with high quality housing* and	clean	, *affordable* energy. Providing the right infrastructure
Innovation Strategy	can enable *a just and inclusive energy transition* through	collaboration	with our international partners. Energy storage and

natural capital' (Industrial Strategy, 2017, p.43) which although bringing in a business perspective, perhaps is less about exploiting market opportunities as much of the sentiment is in the environmental and economic category.

4.4. Finding a balance? (triple paradigm)

Similar to previous categories, data that was coded as being economic, social and environmental had many descriptive elements. However, within this category some key aspirational statements were also made as shown in Table 12.

The first statement on lowering carbon emissions for ourselves and for future generations shows a sense of responsibility and guardianship over the environment that is in keeping with sustainable innovation policy. In these statements we begin to see how sustainability could be addressed and incorporated into innovation policy documents. We should note however, that of the three instances we found in our data, two come from the 2017 Industrial Strategy, with only one coming from the 2021 Innovation Strategy. However, it is also interesting to note that the focus words come from all three paradigms (carbon and clean from environmental, prosperous from social and innovate from economic) suggesting a true cross-pollination between paradigms, including more statements which address all three paradigms would create more sustainable innovation policy.

5. Discussion

The full complexity of environmental and societal issues is challenging to include in any policy document. However, using a critical discourse analysis approach with methods from corpus linguistics we explored the intersections between social, environmental and economic themes in two flagship innovation policy documents. Our approach allowed us to dig deeper beneath keywords and phrases to understand how those terms are used in policy and understand what they signify. We began with two expectations: first, that innovation policy documents would contain an embedded assumption that economic growth has a positive societal effect. We found examples in both texts that supported

Table 12
Concordances - Economic, social and environmental cross paradigm, aspirational theme.

Document	Left context	Keyword/ term	Right context
Industrial Strategy	*We owe it to ourselves and future generations* to lower	carbon	emissions and move towards *cleaner growth*; we are facing a
Innovation Strategy	the measurement infrastructure that the UK needs to	innovate	and be *safer, healthier, greener and more prosperous*. A pro
Industrial Strategy	will have equipped our country for a future that is not just	prosperous	but also *socially and environmentally responsible*. Ideas

this hypothesis which suggests that economic growth is seen as the main means of addressing societal issues.

Secondly, we expected that economic growth would be prioritised over societal and environmental objectives and challenges. In looking at how societal and environmental themes are discussed we discovered that the innovation policy documents utilise environmental and societal language and goals typically when mutually beneficial with economic goals, thus confirming the dominance of the economic themes. Although there are a handful of examples where social and economic words appear without the economic reference point, these are sparse within the documents. Environmental terms that were prominent in the keyness analysis included concepts such as decarbonisation and clean rather than issues such as deforestation or temperature change. Although at first glance, the terms for the social paradigm may appear to include a stronger connection to society (in the term 'young people'), in the contextual analysis of these terms it becomes clear that the aim is to find ways for young people to fit into the existing economic marketplace, rather than to find ways to support young people to achieve fulfilment in their economic activities. The conflation of developing meaningful careers for young people with training young people to fit the marketplace suggests that conflation of aims described by Diedrich et al. (2011) in environmental sustainability through the example of food production (the requirement of more food being conflated with the development of agri-tech systems) is reflected in social as well as environmental issues. The economic narrative dominates. Our analysis found little to indicate that either social or environmental considerations were beginning to temper the economic objectives of innovation policy or that innovation policy was being leveraged to address wicked social or environmental challenges.

While our hypothesis could be critiqued as discussing points we already believe to be true (Kirchherr, 2022), to date, there is no robust empirical data testing these underlying hypotheses. Thus this study has theoretical implications for the ways in which we understand sustainable innovation policy and the ways in which academics can explore the implications of innovation on wider society and the environment. We also make a methodological contribution: our analytical technique provides opportunity for researchers in policymaking to build an understanding of the ways in which sustainability is embedded in policies.

Our core findings suggest that sustainable innovation is not yet fully embedded in the flagship UK innovation policies, however the use of keywords related to social and environmental themes provides some optimism that policymakers are increasingly interested in embedded sustainable innovation into policymaking. Our research suggests that there are opportunities to further balance the three paradigms of sustainability (societal, environmental and economic) in policies even when they have a strong economic focus. Balancing the three paradigms is challenging in any context. However, it is feasible to incorporate more sustainability into innovation policy by looking at the balance of goals, understanding the missing aspects which would build towards greater societal and environmental impact, and ensuring connection between the economic aims, and the societal and environmental outcomes.

We empirically defend that which Diedrich et al. (2011) suggests: behavioural insights and change are still underrepresented in flagship innovation policy documents, suggesting there is a role for more social science insights to be embedded into innovation policymaking, where the focus currently remains firmly on science, technology and engineering. Our finding that technology is preferred over social aspects provides evidence to Fothergill et al.'s (2019) assertions on the same theme. This finding is particularly relevant as policymakers increasingly turn to challenge- and mission-led policy strategies. Crucially, mission-led policy approaches recognise the need for behavioural or social change in addition to technological fixes (Haddad et al., 2019). As governments latch onto the mission-led approach, what is clear is that effectively doing so requires meaningful shifts to ensure that mission definition and execution do not risk perpetuating the patterns of previous generations of innovation policy.

While we find little evidence that this type of shift is currently underway in the UK according to the documents we analyse, it is possible that it is more advanced in other areas of the polity. It is also important to remember that transformation takes time. However, it is possible that new paradigms are encountering, and will continue to encounter, resistance in policy circles and that the growth-led order will continue to dominate. In either case, scholarship should continue to critically examine the evolution of sustainable innovation policy and to refine tools, such as those we employed in this research, to track public sector accountability.

It is appropriate to reflect on the implications of these findings. Does the absence of social and environmental priorities shaping economic objectives in these documents indicate an absence of sustainable innovation policy? First, it is important to acknowledge the limitations of this study. We focused on only two (albeit dense and central) documents with a clear and acknowledged economic focus. It is, therefore, not a surprise that economic objectives are central. Furthermore, if we had expanded our sample further, we may have found more engagement within different types of policy documents. That said, these are precisely the kinds of documents in which we might expect to find statements that support a shift in policy direction and more clearly confronting and proposing strategies to address the clear tensions between economic, social, and environmental agendas and the role of innovation in addressing them, and challenging Government departments to follow suit.

CRediT authorship contribution statement

Lauren Tuckerman: Conceptualization, Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Jen Nelles**: Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **Kevin Walsh**: Conceptualization, Methodology, Formal analysis, Writing – review & editing. **Tim Vorley**: Conceptualization, Writing – review & editing, Funding acquisition.

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The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Lauren Tuckerman reports financial support was provided by UK Research and Innovation. Jen Nelles reports financial support was provided by UK Research and Innovation. Kevin Walsh reports financial support was provided by UK Research and Innovation. Tim Vorley reports financial support was provided by UK Research and Innovation.

Data availability

The data used is freely available through the UK Government Website.

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