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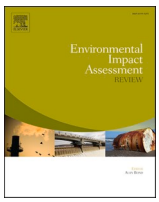

Understanding the impact of environmental impact assessment research on policy and practice

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ABSTRACT

There is an enormous and ever-growing body of environmental impact assessment (EIA) research, much of which is grounded in practice or seeks to advance it. In this paper we show how the impact of EIA research on policy and practice might be conceptualised and how to set about evidencing it. A framework is developed through literature review to account for impact in four areas pertaining to instrumental impact, conceptual impact, capacity building and knowledge brokerage and co-production. Methods for implementing the framework include citations within policy documents along with content analysis to determine influence and interviews or surveys with policy makers and practitioners; all subsequently presented as narratives. We provide examples and further discussion of each, drawn from recent analysis of the EIA research of one of the authors. Whilst proving impact of EIA research on policy and practice is challenging, we found the framework to be a useful way for structuring and guiding such an investigation. This approach to understanding the uptake and influence of EIA research on impact assessment practitioners and other stakeholders (i.e., government regulators/policy-makers, consultants, proponents or NGOs) could be applied by many professionals in the field to showcase positive impact on policy and practice locally, nationally and internationally. It may also usefully serve academic EIA researchers applying for new positions or for promotion within universities.

1. Introduction

The environmental impact assessment (EIA) community comprises a range of professionals engaged in all aspects of impact assessment practice (including but not limited to EIA, strategic environmental assessment, social and health impact assessment), and which might involve development of policies and procedures for EIA as well as teaching, training, and research in the field. EIA professionals often occupy more than one role simultaneously. For example, there are practitioners working for proponents, regulators, consultancies or NGOs who train or offer some teaching at universities (Morrison-Saunders et al., 2020; Morrison-Saunders and Pope, 2021) or who publish papers on EIA policy and practice in journals and on other platforms. Similarly, academics may contribute to the development of policy and practice in various ways, beyond more customary research and teaching duties within the university sector (Bond and Fischer, 2022; Kågström et al., 2023a). Our focus here is on the relationship between EIA research and professional practice. It arose from a formal investigation initiated by the research office of our home university to understand the impact of academic research beyond the walls of academia. At this juncture, we note that metrics regarding academic citations of research (e.g. within databases such as Scopus, Web of Science or Google Scholar) have long been one important measure within university circles for impact of research (which we do not further address). Our principal focus in this paper is on the impact of EIA research specifically outside of the immediate university and research sectors.

The aim of this paper is to understand and to explain how the work of EIA researchers can serve to influence EIA policy and practice. We do this by is by mapping out the pathways that can lead to the uptake of ideas from research by EIA practitioners and other stakeholders (i.e., government regulators/policy-makers, consultants, proponents or NGOs) and how a researcher can establish evidence of influence. In short, this paper is about the contribution that EIA research makes to the broader field.

Our investigation of the impact of EIA research on policy and practice leading to the preparation of this paper, was itself conducted as a

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formal research undertaking. In the next section, we explain the methods we utilised in this regard. In Section 3 we establish a framework for understanding the impact of EIA research based upon literature review. In Section 4, we discuss the methods that an EIA researcher might employ to demonstrate the impact of their own research when applying that framework. In Section 5, we provide a discussion of the lessons learned from our own investigation of the influence of EIA research on practice focused on the research outputs of the lead author. We conclude the paper in Section 6 along with some reflections on the utility of applying our framework that fellow EIA researchers may find useful to guide their own endeavours in determining the impact of their research.

Our findings may be of interest to EIA professionals from many walks of life. Firstly, and generally, we conclude there is value in having the whole EIA community understand the relationships and interfaces between EIA research and practice. Secondly, practitioners, especially those who publish research papers and engage in training or teaching, may encounter new insights regarding how these activities can influence policy and practice on local to international scales. Finally, EIA academics may be able to utilise the ideas we put forward for understanding the impact of their research and other associated university activities in applications for promotion or new positions, to enhance their success here.

2. Methods employed for this research

We commenced our research with a literature review, targeting both peer-reviewed and searchable grey literature alike that specifically addresses research impact. We did not attempt to conduct a systematic literature review, nor attempt to engage with the entire range of available publications on the impact of research; it being a large field in its own right. Instead, we adopted a scoping review process with the aim of mapping "the key concepts underpinning a research area and the main sources and types of evidence available" (Mays et al., 2001, p. 194). Our approach to this review was somewhat opportunistic, using our "existing knowledge and networks" (Badger et al., 2000, p. 223) to guide our searches. Firstly, for example grey literature publications of the Australian Research Council (ARC – Australian Research Council, 2017b, undated) already known to us provided a starting point to provide linkages to other sources as well as ideas for suitable key word searches to adopt. Subsequently we carried out searches in Google Scholar and Scopus databases utilising terms such as 'research impact', 'impact of research' and 'impact on policy' to identify both grey and peer-reviewed literature. Secondly, our research coincided with publication of a special issue of *EIA Review* journal on the topic of collaboration between researchers and practitioners that was published whilst our investigation was underway (e.g., see Kågström et al., 2023b), which the lead author was already aware of (having contributed a paper to it) and which we found to offer much complementary material. This was simply "serendipitous discovery" (Greenhalgh and Peacock, 2005, p. 1065) increasing the value of our searches. Finally, the third author as coordinator of the program at our home university to understand the impact of academic research obtained useful material from other researchers investigating their own research impact. Having identified relevant works, we employed the "snowball" methods of Greenhalgh and Peacock (2005, p. 1065) to pursue "references of references and electronic citation tracking" (p. 1065).

The material we present in our review (in the next section) concentrates on works published in the last decade that focus on research impact associated with environmental sciences (e.g., Penfield et al., 2014; Davila et al., 2016; Edwards and Meagher, 2020; Louder et al., 2021; Posner and Cvitanovic, 2019; Posner et al., 2016, 2020). This includes the EIA studies in the special issue noted previously. We encountered many studies examining impact of other research fields, for example, studies of medical research on health policy were especially prevalent which we excluded from our account here, not finding them to be readily transferrable to an EIA context. Often, simply scanning the titles of materials found in our searches would point to environment-related policy studies of research impact. We also included works more generally addressing the social impact of research (Ofir et al., 2016; Hansson and Polk, 2018; Reed et al., 2018, 2021; Sordé Martí et al., 2020). A characteristic of a majority of sources included in our review is that they provide extensive literature reviews of earlier similar studies (not duplicated here) which we found to be sufficient for our purpose.

Two other inter-related methods underpin this research. Firstly, personal experience plays a big role; being included in the "short list of characteristics of a 'good' qualitative study" by Cresswell (2007, p. 46) and which Bhattacherjee (2012) identifies as an important approach when carrying out "explanatory research" (p. 6). Secondly, we employ reflexivity (e.g. following Pillow, 2003, Subramani, 2019), in which we provide our own observations and reflections arising from the investigation we carried out at our home university, mentioned previously.

3. Understanding how research can influence policy and practice

The Australian Research Council - ARC (ARC – Australian Research Council, 2017a, p5; undated, p2) defines research as "the creation of new knowledge and/or the use of existing knowledge in a new and creative way so as to generate new concepts, methodologies, inventions and understandings". Subsequently, they define research impact as "the demonstratable contribution that research makes to the economy, society, environment, national security, public policy or services, health, the environment, or quality of life, beyond contributions to academia" (ARC, 2017b, undated, p2). The definition of research impact by Reed et al. (2021) is similar, referring to "demonstrable and/or perceptible benefits to individuals, groups, organisations and society (including human and non-human entities in the present and future) that are causally linked (necessarily or sufficiently) to research" (p3). These broad definitions give little specific insight as to applications and influences, or the pathways for such impact to be realised and nor are they universal definitions. In comparison, for example, Louder et al. (2021) and the national UK Research and Innovation organisation (UKRI – UK Research and Innovation, 2022) suggest that – research impact extends past academic, economic and societal impact to include instrumental and conceptual impact, capacity building and knowledge exchange networks. This framing now points to the ways in which research impact can influence professional practices in broader society. We address and explain each of the four considerations in turn, steering our account specifically towards understanding the impact of EIA research on policy and practice in this particular field.

Instrumental impact refers to direct influence on or changes to policy (UKRI, 2022; Louder et al., 2021) affected by the researcher and their published work, also referred to as the "technical merits of the knowledge as the key for utilization" (Kok and Schuit, 2012, p7). This might come about through invitations to directly write policy or make presentations to policy-makers and practitioners as an expert witness or adviser, uptake of suggestions made in submissions to formal review processes and citation of published work within policy and guidance documents (e.g. Penfield et al., 2014; Bond and Fischer, 2022; Pope and Morrison-Saunders, 2022). Instrumental impact can be relatively easy to determine. For example, citations of publications in policy decisions arguably provide direct evidence of societal impact (e.g., Bornmann, 2013; Louder et al., 2021) serving as "tangible metrics" or "output indicators" to borrow the terminology of Edwards & Meagher (2020, p1).

Conceptual impact operates through contributions to understanding policy issues and reframing debates by changing thinking about them (UKRI, 2022; Louder et al., 2021) which may extend variously to changes in knowledge, awareness, attitudes or emotions (Edwards and Meagher, 2020). It roughly conforms with the role of an EIA researcher as a "reflective scientist" (Kågström et al., 2023a, p2) which in this field often entails applied research. Cashmore et al. (2004, p296) noted that

the "theory of EIA is inadequately developed", also observing that much research is practice oriented. Thus, we consider it appropriate to include applied research as a component of conceptual impact in the field, serving to help advance EIA through making recommendations for advancing future practice and extending to "developing practice guidance" (Bond and Fischer, 2022, p4) as an outcome of research activity.

Capacity building arises from knowledge transfer and involves "changes in skills and abilities" (Louder et al., 2021, p. 260) between researchers and policy makers or practitioners (UKRI, 2022). It is no surprise then that teaching, training, and coaching or mentoring of environmental professionals is commonly identified in EIA and other similar fields as part of the role for an effective policy-influencing researcher (e.g., Lindner, 2011; Oliver and Cairney, 2019; Bond and Fischer, 2022; Kågström et al., 2023a; Pope and Morrison-Saunders, 2022). Relatedly, a best practice principle for teaching and training EIA promoted by the International Association for Impact Assessment (IAIA) is that it "incorporates research contributions" to enable learners to "engage with emerging research in the field" (Morrison-Saunders et al., 2020; p339). We also include research supervision here (e.g., DFID, 2010), knowing from personal experience that many students undertake EIA research projects at either Masters or PhD level as a particular pathway for developing skills for their professional careers outside of academia.

Key to impact on policy and practice is knowledge exchange between researchers and policy makers or practitioners (UKRI, 2022; Louder et al., 2021). Other researchers variously refer to this as "knowledge brokering" (Jackson-Bowers et al., 2006, p1; also, similarly Scoble et al., 2010; Kågström et al., 2023a), "research brokers" (Buxton, 2011, p260) and "broker of EIA knowledge" (Pope and Morrison-Saunders, 2022, p3). Other related terms used in the literature include "knowledge systems" (Davila et al., 2016, p11), "researcher-practitioners collaboration" (Kørnøv et al., 2022, p1), "collaboration between academic and non-academic actors" (Pope and Morrison-Saunders, 2022, p1), EIA researchers serving as "change agents" (Kørnøv et al., 2011, p204; Kørnøv et al., 2022, p1) and simply "engagement" (ARC, 2017b, undated, p1). Numerous authors emphasise the importance of two-way dissemination and communication regarding research which should actively involve stakeholders in social processes that include their contributions to the research (e.g., Ofir et al., 2016; Hansson and Polk, 2018; Oliver and Cairney, 2019; Sordé Martí et al., 2020; UKRI, 2022). In describing a model known as "Social Impact Assessment Methods for research and funding instruments through the study of Productive Interactions (SIAMPI)" (Penfield et al., 2014, p24) note that this is based on the "widely held assumption that interactions between researchers and stakeholder are an important pre-requisite to achieving impact" (p24).

Such interactions between researchers and those working as policy-makers or practitioners, referred to as "boundary spanning" by Posner & Cvitanovic (2019, p141) increase the robustness and legitimacy of research (Posner et al., 2016) and ultimately will help to "align research and policymaking and increase the uptake of research in decision making" (Posner et al., 2020, p1760). Many researchers specifically advocate co-production of research with relevant stakeholders (e.g. Hansson and Polk, 2018; Reed et al., 2018; Norström et al., 2020; Edwards and Meagher, 2020; Louder et al., 2021), underscoring the importance of relationships between researchers and their stakeholders. Adoption of specific research methods such as participative research (e.g. Cargo and Mercer, 2008) or participative action research (e.g. Greenwood et al., 1993) ensures the emergence of research in partnership with community or other stakeholders; an approach evident in EIA scholarship (e.g. Kwiatkowski, 2011; Grilli et al., 2021). These research approaches have an equivalent in EIA practices known as "community-based environmental assessment" (e.g. Biswal et al., 2023, p1). Beyond collaborative or participatory research, co-authorship and co-production, researchers can also give presentations or convene workshops (at conferences or other events) and accept invitations to provide peer reviews of policy documents or undertake research consultancies for policy organisations (Kørnøv et al., 2011; Bond and Fischer, 2022). Here we adopt the term *knowledge brokerage and co-production* to capture all these considerations.

Fig. 1 presents a framework summarising the four ways in which the impact of IA research on policy and practice can be understood and examined based on our preceding discussion. It has some similarities, albeit in a much simpler form, with the diagram depicting the "payback" framework espoused by Buxton & Hanney (1996, p35) and Donovan & Hanney (2011, p182) which "characterizes research projects in terms of Inputs, Processes, and Primary Outputs" (Buxton and Hanney, 1996, p35). For example, there is overlap with two of the paybacks of research identified by Donovan and Hanney (2011) pertaining to "improved information bases for political and executive decisions" (p182) and "adoption by practitioners and public" (p182). We also note here that Penfield et al. (2014) suggest that the Payback Framework "is possibly the most widely used and adapted model" (p23) for understanding and accounting for the impact of research.

In our framework, instrumental impact intersects with academic citations of research (mentioned in the Introduction) as we found that GoogleScholar does record some policy documents (i.e., grey literature) and thus citations of research publications within these. Similarly, the four components of our framework are inter-related and the boundaries of them as depicted in Fig. 1 should not be thought of in rigid terms. It is well noted in the literature that policy research impact and its effect on society, public policy and the environment is non-linear, messy and complex and it takes time (Donovan and Hanney, 2011; Lindner, 2011; Ofir et al., 2016; Reed et al., 2018; Oliver and Cairney, 2019; Edwards and Meagher, 2020; Posner et al., 2020; Louder et al., 2021). For example, Reed et al. (2018) note that "changes in understanding occur as researchers and policy communities influence each other and together learn new concepts, attitudes, capacities and policy options through processes of social interaction" (p432), all of which "presents a huge methodological challenge" (p432). Thus, impact is iterative and can be difficult to capture, it need not be directly causal or linear, is often incremental and generally involves influencing policy makers and practitioners about how the emerging knowledge is to be understood and applied, woven through multiple sources and types of knowledge (Posner et al., 2020; Reed et al., 2018). It is also argued by Donovan and Hanney (2011) that "any impact is the product of the whole R&D system and not exclusively produced by the original researchers themselves" (p260). Also, as pointed out by Ofir et al. (2016), the individual sphere of control for researchers is limited relative to the potential spheres of practice or influence relevant to the research goals or potential contribution.

Notwithstanding these caveats for applying our framework, we believe that it provides a means to attempt to document the impact of the endeavours of a single researcher bearing in mind that oftentimes much of this knowledge is co-authored and co-produced. The quotation much utilised in scientific circles that each individual researcher is "standing on the shoulders of giants"[1] resonates for us here. It is to be hoped that one EIA researcher learns from the work of those that have gone before them (and which they have cited in the account of their own research). Thus, an indirect influence can be expected to trickle through the whole body of knowledge and behaviours of practice when each individual EIA researcher in turn is considered in the framework for understanding the dynamic impact of research.

[1] This quotation is attributed to Isaac Newton when writing to Robert Hooke in 1675 (e.g. https://discover.hsp.org/Record/dc-9792/Description#tabnav) but seemingly has older roots in the writing of John of Salisbury in 1159 (e.g. https://www.phrases.org.uk/meanings/268025.html) [both sources accessed 31 August 2023].

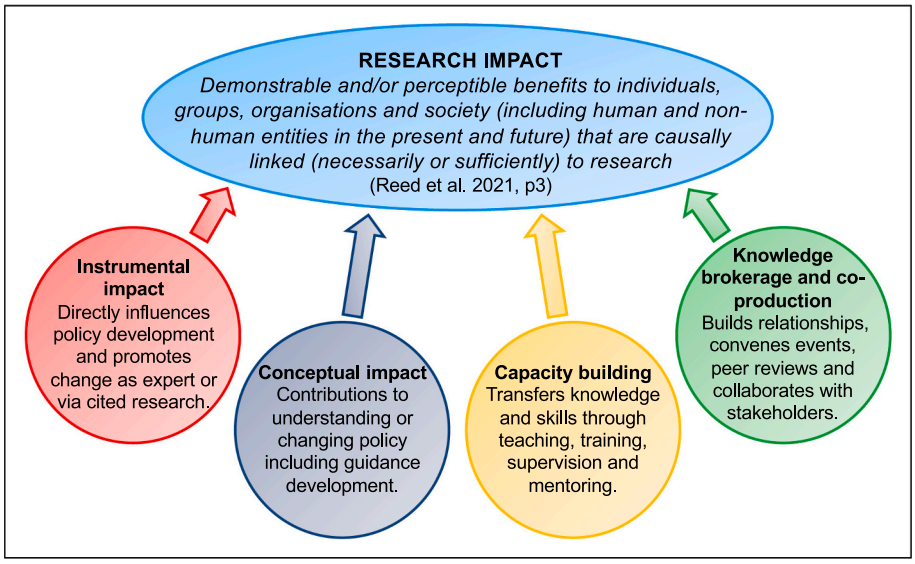

Fig. 1. Framework for understanding impact of environmental impact assessment research.

4. How to develop evidence of the impact of EIA research

In this section we explain methods that can be used to apply the framework. This content thus explains how a researcher can establish evidence regarding the influence of their research. Some of the literature we reviewed in the previous section outlines several inter-related approaches for how a researcher might go about investigating and demonstrating the impact of their research. For example, Penfield et al. (2014) and Posner and Cvitanovic (2019) advocate using a mixed methods approach that includes metrics, interviews or surveys and content analysis. Similar methods are also used by Kørnøv et al. (2022) in an EIA context. When combined, these help to triangulate findings (Jonsen and Jehn, 2009). In summary, these methods and their relationship with the components of our framework in Fig. 1 are addressed in turn.

Citations of academic research publications in EIA policy and practice documents provide an immediate evidence base for *Instrumental impact* (e.g. identified using Google Scholar or other searches as explained later on).

Content analysis can be used once policy or guidance materials from practice relevant to the EIA research under investigation have been located by one or more of the previous methods. Here, the goal is to provide some tangible evidence of the influence of the research which may provide "a valuable, but incomplete, view of the impact" (Posner and Cvitanovic, 2019, p146) of the research and of the knowledge brokerage efforts of the researcher. Such approaches may however also "require software to analyze large volume of content" (Posner and Cvitanovic, 2019, p146) if the understanding of impact is to be extended beyond attribution of source material through citation.

Interviews or **surveys** can be carried out with "end-users" of research to provide "evidence of knowledge exchange, or a demonstration of change in public opinion as a result of research" (Penfield et al., 2014, p29). These approaches enable the perceptions of policy makers and practitioners for the uptake or applications of research to be investigated, as well as understanding of what determines how this comes about, for example the "barriers and opportunities for translating research into practice" (Posner and Cvitanovic, 2019, p146). They thus contribute to understanding *Instrumental impact*, *Conceptual impact* and *Capacity building* alike. They may be relevant in obtaining insights from stakeholders that a researcher already has an established relationship with through *Knowledge brokerage and co-production*, notwithstanding that personal reflections or insights may suffice here. Penfield et al. (2014) further note that interviews and surveys are time consuming and need to be undertaken while the impact of research is still fresh or current, rather than retrospectively. Moreover, workforce changes over time can reduce the ability of a researcher to access relevant stakeholders for the purpose of interviews or surveys.

These three methods used in combination should generate a rich body of data. A useful way to present such results is in a narrative form to "describe impact" Penfield et al., 2014, p29) thereby enabling "a story to be told and the impact to be placed in context" (p29). Other similar terms used include, for example, the notion of a series of case studies (ARC, 2017b, undated) constructed of "impact narratives" (Edwards and Meagher, 2020, p2). These have also been referred to variously as "narrative impact evaluation" (Reed et al., 2018, p447), "testimonials" (Penfield et al., 2014, p29; Reichard et al., 2020, p5; Reed et al., 2021, p4); "statements from end-users" (Reed et al., 2021, p5) or "impact case studies" (Reichard et al., 2020, p1).

5. Lessons learnt from applying the framework for understanding impact of EIA research

In reflecting, as part of the investigation we carried out at our home university (which was to understand the impact of the research of the lead author), we encountered some surprises and developed insights into how our framework can be applied. We share just these lessons learned here, addressing each component of the framework in turn.

We were able to document some evidence of instrumental impact in a variety of ways. With Google Scholar it was possible to locate policy or guidance documents produced by regulators and NGOs that cited research papers of the lead author. We noted however, that the works found were clearly skewed to particular organisations or jurisdictions (e.g., especially works of the United Nations or US Government agencies) which we attribute to information disclosure practices and availability of public repositories. However, many policy documents we found that in some way cited or referenced published work of the lead author were not revealed in Google Scholar searches. These documents were located partly by chance or serendipity (an aspect of impact research noted by Penfield et al., 2014). Sometimes, because the lead author had participated in a particular review of EIA policies or procedures initiated by a regulator or other organisation, these provided an impetus for some sleuthing to try and determine evidence of influence. This required manual searching of links and documents within the webpages of these organisations as we found that the search functions on many sites did not locate works based upon searches of the lead author's name or of titles of published works, even where documents published by the host

organisation included full citations of research papers in a formal reference list. We also conducted open searches on the internet (e.g. using the Quant search engine) utilising the surname of the lead author in combination with relevant key words associated with some of their particular research projects. These were selected based on a 'hunch' that these might be influential on policy or practice, including an emphasis on material published as open access since, as documented in Pope and Morrison-Saunders (2022) it seems that EIA professionals either do not have access to academic databases or else are too busy to carry out perform literature reviews of academic works. That said, we noticed that fellow academics engaged by industry to prepare EIA policy advice (e.g. through research consultancies if not by direct authorship) do cite subscription only journal papers and academic books or chapters in their reports.

These searches occasionally turned up useful results (many did not). We then used snowballing from cited texts, reference lists of cited texts, interviewees or other cited sources. Sometimes, by pure chance, we located reports engaging in research work of the lead author making no mention of names or titles of research papers, but simply alluding to content that could clearly be linked to particular research undertaken (i.e. known only to the lead author because of the specific circumstances or context). Several practitioners whom we approached for interviews remarked to us that policy is developed and written without any academic references at all, although some suggested that the ideas arising from research may nevertheless be influential on policy content. Some of the practitioners interviewed knew of documents citing research of the lead that the research team were previously unaware of.

We found one clear example of instrumental impact that extended from citation of research and was made evident through content analysis. The lead author had been formally consulted as part of an independent review of EIA procedures in the local jurisdiction. Not only were some research publications of the lead author (interestingly only open access works) cited in the advice subsequently provided to regulators in a review report of the lawyers who authored this, but because specific terminology was employed which appeared in the revised EIA procedures, we were able to trace a clear pathway of causality. To explain further, specific terminology utilised in a research publication of the lead author, was cited and discussed by the lawyer in their independent review and subsequent to this, the same unique terminology was adopted in revised EIA procedures by the regulator to whom the independent review was directed. This was something of a unique example. More often we had to speculate or draw linkages between content known to have been contributed to EIA regulators or policy makers and subsequent related material appearing in EIA procedures. While we have some confidence in making such links, it is difficult to prove causality as desirable in the definition of research impact from Reed et al. (2021) we utilised in our framework (Fig. 1).

Perhaps not surprisingly, we found demonstrating conceptual impact to be the trickiest aspect of implementing our framework. Here, we relied on testimonies of interviewees alone, providing us with personal accounts or examples where they had utilised EIA research material in their own professional practice in some way. It was, not unsurprisingly easiest to document conceptual impact where EIA research is captured in practitioner resource guides and materials authored by the same researchers. A specific example here pertains to the IAIA best practice principles for EIA follow-up that the lead author was involved with in two iterations over two decades (e.g. Marshall et al., 2005; Morrison-Saunders et al., 2021; Arts and Morrison-Saunders, 2022) We noted that some interviewees emphasised that they now work with young professionals whom they have trained and mentored (i.e. suggesting that the conceptual impact of research could have an inter-generational dimension).

Capacity building was relatively easy to account for. However, this also relied upon testimonials of interviewees recalling valuable insights that they had gleaned from their participation in particular training events conducted by the lead author. Here we reproduce a point in Pope and Morrison-Saunders (2022) regarding trainer perceptions of potential influence on the practices of EIA professionals:

> Although we cannot prove that such knowledge sharing has altered local EIA practice, we have noticed the work of some individuals whom have attended our training courses being adapted to accommodate some of the ideas we had promoted (p. 3).

Thus, while we are unable to demonstrate causality, we are confident that capacity building is an especially important vehicle for research impact. To some extent feedback from training course evaluations can also be utilised here; the caveat here being that most training course evaluations are about immediate satisfaction with the quality of a course just delivered and do not extend to how the new learning might be applied in practice. For researchers who run training courses, it may be fruitful to implement post-course surveys with participants some months later to try and 'test' for uptake and application of taught content in EIA practice. This might be undertaken in the context of implementing a best practice principle for EIA teaching and training to include "mentorship and post-course support" (Morrison-Saunders et al., 2020, p. 9). Supervision of successful Masters and PhD completions by industry professionals may also be used as a measure of capacity building, especially as these students typically undertake applied research related to EIA practice in our experience. We did not attempt to interview former students in our own investigation, but it would be relatively easy to undertake (e.g., academics often stay in contact with their former students, while university alumni associations may provide other ways to link up with them).

Accounting for knowledge brokerage and co-production is relatively straightforward since the researcher can reflect upon their own experiences directly. Ongoing collaborative relationships between academic researchers and industry practitioners can be evidenced in citation searches but we also encountered cases where these were corroborated by interviewee testimonials. Peer reviews of policy documents are normally acknowledged in the published works themselves, although it can be challenging to point to particular influence attributable to an individual researcher within those documents with full confidence or evidence of causality. Other activities such as editing professional journals or books, coordinating special issues of journals and hosting workshops at conferences (all of which the lead author has carried out numerous times) in which EIA practitioners are encouraged and supported to publish or present accounts of their own work are also demonstratable outcomes of knowledge brokerage (and arguably capacity building, reiterating that the framework boundaries are not rigid). If any of these forms of research activity have been co-authored or co-presented with industry partners, it is reasonable to assume that the ideas have been absorbed or applied to some extent by or within that partner organisation. The extent of this impact of research may only be modest and localised, depending upon the nature and scope of the organisations involved. This was apparent from testimonies of social researchers at our home university regarding the significance and reach of participatory action research. These undertakings had been conducted by deeply connected researchers with some type of non-academic experience in the field (lived experience and industry experience). These research projects produced very significant impact, but only at a localised level. Taking this to scale would require deliberate work to adapt for other contexts. We also noted that the researchers involved were mid-career or older researchers (i.e., meaning that they are very experienced and well established within their fields); a factor likely relevant for knowledge brokerage and co-production more generally.

While there is an assumption that knowledge brokerage impact will be positive and meaningful, Kågström et al. (2023a) mention that not all EIA research impacts led to practice improvement. There is clearly more than just knowledge advancement at stake with respect to affecting change in established EIA policies and procedures. Collaborative relationships also require sustained work and trust, and there are some barriers (perceived and actual) between institutions and industry with

collaborative partnerships not occurring as often as they once did due to a range of factors including time and money (Bond and Fischer, 2022; Pope and Morrison-Saunders, 2022; Kågström et al., 2023a).

Demonstrating the various indirect routes to impact, other investigations of research impact at our home university identified the influence of research upon undergraduate curriculum as a pathway to impact. Another identified the value of partnering with purpose-oriented stakeholders whose mission aligned with the inherent goals of the research, thus sharing the work of knowledge brokering. Consistently, the importance of connection and communication between parties within and external to the university was identified as an enabling factor in generating research impact.

6. Conclusions and reflections on applying the framework for understanding impact of EIA research

In this research we set out to understand how EIA research can impact on policy and practice and the means for evidencing it. Through literature review we established a framework for conceptualising and identifying four types of impact. We explained the methods underpinning application of the framework and our experiences in applying it ourselves. Here we reflect on the utility of this framework for use by EIA researchers.

The main benefit of our framework is that it revealed various ways in which the impact of EIA research might be understood that we had not previously thought about. Prior to undertaking our investigation (and disregarding academic citation metrics here), we had chiefly only considered citations of research publications in grey literature (i.e. policy or EIA guidance materials) and miscellaneous feedback from former students or trainees we had received that suggested they had been inspired by taught content we had provided. Whilst we were aware of the co-benefits of knowledge brokerage and co-production (i.e., having actively worked with many other professionals), we had not sought to frame or understand this as impact of research.

The framework is simple and as we noted in Section 3, the four components are inter-related to an extent. More specifically, instrumental impact, conceptual impact and capacity building are arguably substantive in nature (i.e., they more or less pertain to direct impact of research), whilst knowledge brokerage and co-production is more a means for how each of these three types of impact might be realised. This distinction is apparent also in the way in which Louder et al. (2021) and UKRI (2022) present their textual account of the four components. Nevertheless, we maintain that our framing for the four components in Fig. 1 is a helpful construct.

Examination of research citations in policy documents and associated content analysis to try and demonstrate causality (i.e. transfer of knowledge from research into policy) was a valuable undertaking in its own right. This can of course be conducted as a desk-top exercise and does not require ethics permission (e.g., from a university ethics committee). As indicated previously, personal experience provided clues as to where to go looking for such evidence of influence in the first instance (i.e., beyond searches in Google Scholar or the internet more broadly). However, it was the interviews that provided essential insights for our examination of the impact of the EIA research of the lead author. Here, it was important that interviews be conducted by a third party and to provide interviewees with guaranteed anonymity. Hence, this part of our data gathering was undertaken by the second author acting independently of the lead author, notwithstanding that they had made suggestions for who to approach for interviews. The interview transcripts and initial coding of them were kept confidential and the lead author has not had access to them. Only non-identifiable comments were included within the report on our investigation at our home university. Some personal bias may have been introduced as many of the interviewees were friends or colleagues of the primary researcher and fellow members of IAIA. However, in the context of *Knowledge brokerage and co-production*, this is largely going to be inevitable (and conversely, it is not practical to attempt to randomly target unknown policy makers or practitioners, given the possibility that research might influence practice within any EIA jurisdiction worldwide).

Our final reflections on the utility of the framework and the process of understanding and demonstrating the impact of EIA research echo some of the observations we made in the previous section. It is relatively easy to document the activities that provide opportunity for research to be applied in practice (e.g. citations in policy documents, capacity building activities, relationships and events with stakeholders external to the university sector). It remains difficult to attribute causality, especially in relation to conceptual impact. However, a pleasant surprise for the lead author was the realisation that perhaps such influence has been occurring and more than anticipated. Most satisfying of all however was understanding the richness of the EIA research ecosystem by investigating the impact of research in the first place and being able to be part of that. One consequence of having conducted this research is that we now think differently about how we will approach future research activities. Much of our own behaviours will not be fundamentally different; for example, we were already doing knowledge brokerage and co-production along with capacity building, as well as participating in opportunities to serve as an expert witness or peer reviewer of policy whenever they arose. We will continue with these pro-active approaches. However, we have developed a sharper sense of how we might influence EIA practitioners a little more as learned from our examination of theory and testing of the framework with the research of the lead author. In particular, we will be much more tuned into documenting and seeking out evidence of research impact as it occurs, (i.e., actively looking for it) rather than trying to retrospectively account for it.

Overall, by means of citation searches, content analysis and interviews, our study suggests that demonstrating tangible links between EIA research and practice is possible. It thus helps cement the value of the multiple roles and relationships in the EIA profession which is often practice-driven. We hope that many professionals and practitioners can benefit from our insights to enhance development of the field into the future.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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