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Lost learnings: Breaking the silence of failure in the energy and development sector

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ABSTRACT

It is often said that in order to succeed, one most fail and yet, all too often, we fail to talk about failure. This is particularly true in energy and development (E&D), a sector that faces complex challenges leading to relatively high chances of project failure. This paper explores failure in E&D, specifically how it is discussed, its impact and mechanisms encourage discussion of failure. This was achieved through a review of academic literature, workshops and informal interviews, and is the first study to holistically examine the important topic of failure in E&D. The results show that failure is complex and linked to multiple factors. There is an important distinction to be made between "productive failures", where new learnings are assimilated and shared, and "unproductive failures", where this does not happen. Although failed projects consume scarce resources, reduce the productivity of the sector and increase the perceived risk of future projects, we argue that failure is a necessary part of experimentation and risk taking that generates new knowledge and important learnings. Changes to the nature of funding in the sector, compulsory project or research registration, open-source reporting on productive failure and networks that provide safe spaces for peer-to-peer learning could improve openness about failure. These mechanisms could increase the likelihood of future project success and accelerate progress towards Sustainable Development Goal 7.

1. Introduction

Despite its important role in learning to succeed, the word 'failure' is loaded with negative connotations. As the philosopher Morihei Ueshiba argued: "Failure is the key to success; each mistake teaches us something". Yet dialogue about failure is not the norm in the field of energy and development (E&D). This could suggest that failure does not happen in E&D. However, our experiences are to the contrary. Almost every practitioner[1] or academic in the field has an anecdote about a failed project that was never formally disseminated, particularly not outside of their own organisations. These foregone learnings are a stark omission given that E&D comprises two of the biggest energy-related challenges facing our society today: the global transition to sustainable energy and the provision of universal energy access for all, neither of which are on track to be achieved by 2030 as required by Sustainable Development Goal 7 (SDG7) [1]. The urgency of these problems begs the question: why is the E&D community failing to talk about failure?

Our aversion to failure is multi-faceted. At an individual level there is considerable variation in our attitudes towards success and failure, with fear of failure sometimes acting as a positive self-protection mechanism and, at other times, causing anxiety and a feeling of under-achievement [2]. This can affect both our tolerance for risk and our willingness to process and share our experiences [3]. Publication bias has been shown to be rife across a range of academic fields, although to our knowledge nobody has yet looked specifically at E&D. A 2014 review of survey-based experiments on American adults demonstrated the magnitude of these problems, finding that, statistically, strong and positive results are 60 % more likely to be written up and 40 % more likely to be published

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[1] In this paper, we refer to practitioners as those implementing energy projects, programmes or interventions in non-profit organisations (typically NGOs) and for-profit enterprises (social enterprises, private sector companies, etc.).

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[4]. Editors may fear that publishing accounts of failure could stigmatise the projects or individuals concerned, compounding publication bias. Finally, our ability to be open about failure is heavily dependent on the culture in which we operate. Organisations across all sectors struggle to effectively learn from failure because of the perceived need to hold people accountable when things do not go according to plan – even though research has found that the majority of workplace failures are far from "blameworthy" mistakes [5].

Knowledge about E&D is generated by a wide range of stakeholders – including academics, private sector actors, policy makers and NGOs – who shift between being collaborators, competitors, funders and contractors. This leads to a fundamental knowledge management challenge where each organisation type values different types of knowledge, records information differently, and favours different dissemination channels. There is also variation in the funding streams utilised by the different stakeholders. Academics and NGOs rely heavily on money from the public sector, which is both scarce and political. The pressure to succeed in these sectors is significant and candour about failure can jeopardise both future projects and individual careers. The private sector is no less affected by equivalent dynamics from shareholders and faces additional dilemmas in balancing altruistic good practice in sharing against the need to nurture their competitive advantage.

These factors converge on a regressive spiral of avoiding risk, evading responsibility and concealing failure. In E&D this is compounded by a set of additional challenges that are not exclusive to the discipline but are unique in their combination. Firstly, E&D projects have a relatively high likelihood of failure. They tend to take place in difficult contexts and involve working with challenging combinations of technology and people. On top of this, it is a rapidly changing field where projects must address specific sets of political, geographical, technical and social factors. This means that learnings may not be transferrable to other settings, or to the future, regardless of how well – or poorly - the project was executed [6]. In such settings, even the most seasoned practitioners may struggle to deliver 'successful' projects.

These insights come from our own experiences of working in the space and explain why we think failure in E&D merits further attention. The research presented in this paper results from a project that aimed to scope the status quo of failure in E&D and to assess the appetite for discussing the topic further. Therefore, the objectives of this paper are as follows: firstly, to investigate how failure is discussed in E&D; secondly, to draw upon insights from stakeholder engagement workshops and informal interviews to understand what prevents the E&D community from sharing failures; thirdly, to produce a framework that explains the dynamics of failure and how it affects the wider E&D sector; and lastly, to identify mechanisms that could be implemented to improve sharing of failure in E&D.

The structure of the paper is as follows: in Section 2, we present the research methods used in this study. Section 3 covers results and a discussion of findings which feed into the developed framework, which is introduced in Section 4. Section 5 discusses the results and Section 6 offers conclusions.

2. Research methods

The research presented in this paper is exploratory: we aim to investigate failure in E&D, and to stimulate a discussion about how we can incentivise or encourage academics and practitioners to share their failures. To this end, we used qualitative research methods consisting of a review of peer-reviewed literature on failure in the E&D space, expert workshops and informal interviews. Rich qualitative insights have allowed us to develop a conceptual framework to show how failed projects affect progress towards SDG7.

2.1. Literature review

A review of the academic literature was conducted to understand how failure is written about in E&D. Limited resources meant we confined our search to five journals specialising in energy research: Energy for Sustainable Development, Energy Policy, Energy Research & Social Science, Environmental Research Letters and Nature Energy. We searched Scopus for original articles published in each of these journals that were published in any year and contained the word "fail*" in the abstract, title or keywords (N = 737). We excluded papers that were not focussed on the global South and that used the word 'fail' in an irrelevant context[2] (N = 77). Identifying literature about failure is challenging because of the aversion to using blunt terminology to label projects, policies and programmes. This search strategy would have missed out the considerable number of papers that described unsuccessful endeavours but did not explicitly use the word "fail". Identifying all instances of failure in the energy access sector would have required searching hundreds of synonyms of the word "fail", which was beyond this paper's scope and resourcing. However, it did successfully identify a number of papers that explicitly discussed failure and could be used to support a qualitative analysis of how failure is portrayed when it is called out openly. Finally, we only considered articles about off-grid electricity generation and cooking projects, specifically: biogas, ethanol, improved cookstoves (ICS), LPG, micro-hydro systems, mini grids and solar (N = 38). These are the most common technologies used to deliver access to modern energy services in the global South. A summary of papers is shown in Table 1 below and the final inclusion list in Table 2.

The purpose of this review was not to investigate the root causes of success and failure. For this we point the reader towards the work of other scholars including Sovacool's design principles for successful renewable energy programmes [7], Ilskog's framework for sustainability considerations of renewable energy projects [8] and Subbarao's indicators for assessing the sustainable development contribution of Clean Development Mechanism projects [9].

2.2. Workshops and informal interviews

We held two scoping workshops in July 2021 with experts who work in the E&D field: one with academics (N = 6) and one predominantly with non-academics (N = 8), including private-sector practitioners, consultants, NGO workers and one academic. The small sample size was a result of time and budgetary-constraints associated with the funding received for this project. Participants were, for the same reason, limited

Table 1
Summary of included literature.

	Category	Number of papers
Geographical region	East Asia & Pacific	13
	Sub-Saharan Africa	10
	Multiple	7
	Latin America & Caribbean	3
	South Asia	3
	Europe & Central Asia	1
	Middle East & North Africa	1
Technology	Multiple	11
	Solar	10
	Biogas	6
	Microhydro	3
	Ethanol	2
	ICS	2
	LPG	2
	Minigrid	2

[2] An example of an irrelevant context might be "participants failed to see the importance of…" – so the word 'fail' was used but the paper was not focused on failure as this project understood it.

Table 2
Literature identified through search.

Title	Reference	Year	End use type	Technology	Location
A framework for evaluating the current level of success of micro-hydropower schemes in remote communities of developing countries	[24]	2018	Electricity	Microhydro	Nepal, Bolivia, Cambodia, Philippines
A new integral management model and evaluation method to enhance sustainability of renewable energy projects for energy and sanitation services	[43]	2015	Electricity	Multiple	Peru
A qualitative factor analysis of renewable energy and Sustainable Energy for All (SE4ALL) in the Asia-Pacific	[7]	2013	Unspecified	Multiple	N/A
A survey of solar PV program implementers in Asia and the Pacific regions	[34]	2009	Electricity	Solar	Asia
Assessing the success and failure of biogas units in Israel: Social niches, practices, and transitions among Bedouin villages	[44]	2020	Cooking	Biogas	Israel
Biogas - a review of Sri Lanka's performance with a renewable energy technology	[20]	2002	Cooking & lighting	Biogas	Sri Lanka
Can the Clean Development Mechanism (CDM) deliver?	[9]	2011	Electricity	Multiple	N/A
Development aid and the diffusion of technology: Improved cookstoves in Kenya and Rwanda	[45]	2017	Cooking	ICS	Kenya, Rwanda
Diffusion of solar water heaters in regional China: Economic feasibility and policy effectiveness evaluation	[46]	2014	Water heating	Solar	China
Dis-adoption of Household Biogas technologies in Central Uganda	[47]	2017	Cooking & lighting	Biogas	Uganda
Dissemination of solar photovoltaics: A study on the government programme to promote solar lantern in India	[21]	2003	Lighting	Solar	India
Effects of load estimation error on small-scale off-grid photovoltaic system design, cost and reliability	[48]	2016	Electricity	Solar	Malawi
End-user perceptions of success and failure: Narratives from a natural laboratory of rural electrification projects in Malaysian Borneo	[27]	2020	Electricity	Multiple	Malaysia
Energy poverty reduction by fuel switching. Impact evaluation of the LPG conversion program in Indonesia	[19]	2014	Cooking	LPG	Indonesia
Evaluation of choices for sustainable rural electrification in developing countries: A multicriteria approach	[49]	2013	Electricity	Multiple	N/A
Examining the small renewable energy power (SREP) program in Malaysia	[33]	2011	Electricity	Multiple	Malaysia
Household energy transition in Sahelian cities: An analysis of the failure of 30 years of energy policies in Bamako, Mali	[17]	2019	Cooking	LPG	Mali
Improved stoves in developing countries. A critique	[32]	1987	Cooking	ICS	N/A
Indicators for assessment of rural electrification-An approach for the comparison of apples and pears	[50]	2008	Electricity	Multiple	N/A
Issues of small scale renewable energy systems installed in rural Soum centres in Mongolia	[26]	2015	Electricity	Multiple	Mongolia
Market-based biogas sector development in least developed countries -The case of Cambodia	[35]	2013	Cooking & lighting	Biogas	Cambodia
Photovoltaic module quality in the Kenyan solar home systems market	[31]	2002	Electricity	Solar	Kenya
Practical constraints for photovoltaic appliances in rural areas of developing countries: Lessons learnt from monitoring of stand-alone systems in remote health posts of North Gondar Zone, Ethiopia	[28]	2017	Electricity	Solar	Ethiopia
Renewable energy partnerships in development cooperation: Towards a relational understanding of technical assistance	[36]	2015	Unspecified	Multiple	Central America
Renewable energy technology acceptance in Peninsular Malaysia	[30]	2016	Unspecified	Multiple	Malaysia
Rethinking the sustainability and institutional governance of electricity access and mini-grids: Electricity as a common pool resource	[51]	2018	Electricity	Minigrid	Kenya
Small-scale bioenergy projects in rural China: Lessons to be learnt	[18]	2008	Cooking & lighting	Biogas	China
Social, economic, and environmental impacts assessment of a village-scale modern biomass energy project in Jilin province, China: local outcomes and lessons learned	[29]	2005	Cooking & lighting	Biogas	China
Solar cooking in Senegalese villages: An application of best-worst scaling	[22]	2014	Cooking	Solar	Senegal
Success and failure in the political economy of solar electrification: Lessons from World Bank Solar Home System (SHS) projects in Sri Lanka and Indonesia	[52]	2018	Electricity	Solar	Sri Lanka, Indonesia
Sustainable performance challenges of rural microgrids: Analysis of incentives and policy framework in Indonesia	[16]	2019	Electricity	Minigrid	Indonesia
Thailand's solar white elephants: An analysis of 15yr of solar battery charging programmes in northern Thailand	[23]	2004	Electricity	Solar	Thailand
The energy transition	[53]	1992	Cooking	Multiple	N/A
The quiet (energy) revolution: Analysing the dissemination of photovoltaic power systems in Kenya	[13]	1996	Electricity	Solar	Kenya
Towards an ethnography of small hydropower in China: Rural electrification, socioeconomic development and furtive hydroscapes	[40]	2019	Electricity	Microhydro	China
Understanding sustainable operation of micro-hydropower: a field study in Nepal	[25]	2020	Electricity	Microhydro	Nepal
Understanding the failures in developing domestic ethanol markets: Unpacking the ethanol paradox in Guatemala	[54]	2020	Cooking	Ethanol	Guatemala
User perceptions about the adoption and use of ethanol fuel and cookstoves in Maputo, Mozambique	[12]	2018	Cooking	Ethanol	Mozambique

to UK actors only, although all of them work internationally in low- and middle-income countries. The workshops were held under the Chatham House Rule [11]. Each workshop lasted for 2 h and took place online using Zoom. They explored perceptions of what failure means in E&D, how it is talked about and our own experiences of failed projects.

In addition to the workshops, we held four informal interviews with a donor, a private sector representative and two academics. All interviews were held online. The interviews explored similar topics to the workshops, but had a greater emphasis on each participant's personal experiences with failure.

The research was granted ethical approval by the Principal Investigator's (Tomei) academic department, the UCL Institute for

Sustainable Resources. All contributions have been anonymised.

2.3. Limitations

The literature review was based on a single search term and a small number of academic-only, English-language sources. It was not exhaustive and did not, for example, identify one of the most extreme examples of programme failure we are aware of: the diffusion of solar home systems in Papua New Guinea [10]. Whilst this is an important limitation, our primary intention was to examine the way in which project failures are discussed in the rare instances where they are explicitly called a failure, rather than to directly examine all project failures (ever reported, under different terms and in different languages) themselves. In this sense it was fit for purpose.

We acknowledge that the very real problem of publication bias also means that our 38 papers likely give a very incomplete picture of failure as seen through the lens of peer review. We have attempted to compensate for this shortcoming by combining the results with insights from the workshops, which were designed to examine the more hidden side of failure. Similarly, we acknowledge that the small scale of the project has led to both a small sample size and to an uneven participation across different stakeholder types. This is true for the interviews and for the workshops, and is a limitation of this study. This makes disaggregation of results across different groups and the generalisation of initial findings difficult. Considering the interesting and important nature of these findings, we see this as an opportunity for other research teams to take this line of investigation further.

3. Results

3.1. Literature review

The literature review identified N = 38 relevant papers. Whilst the motivations behind the choice of topic were often unclear, a minority of papers had explicitly set out to write about failure (N = 14, 37 %) and we could not identify any first-hand accounts of failure from our sample. The overwhelming focus was on NGO projects and government programmes although private sector failures were alluded to in two instances, but not analysed in depth [12,13].

3.1.1. Characterising failure

Only one paper gave a clear definition of success and failure: "*We took a rather simple notion of failure to mean a 'successful' project met its goals or produced benefits that exceeded costs; a 'failed' project did not meet its goals or had costs that outweighed benefits*" [14, p. 2]. Others seemed to assume a similar definition without explicitly stating so. However, linking success solely to project objectives can be overly simplistic and misleading, especially in the face of goal displacement, which may occur when short-term outputs are prioritised over developmental impact [15,16]. In this context, developmental impact links to the goals of SDG7, i.e. the delivery of access to modern energy services, and can be assumed to be the ultimate objective of any work in the E&D space. We found multiple examples of projects, programmes and policies that appeared to be successful, according to self-defined metrics, but had actually fallen short of addressing fundamental energy access issues [16,17]. For example, a government-funded programme in China successfully installed small-scale bioenergy plants throughout rural Shandong Province over the course of a decade, but on-the-ground usage and impacts on recipient communities were negligible [18]. In Indonesia, a large government programme aimed at promoting LPG successfully caused a large-scale shift from kerosene, but led to increased stacking of fuels (including use of traditional biomass) and failed to significantly reduce energy poverty [19].

Failure is complex and there were no papers that attributed it to a single cause, although the most common was improper consideration of end-user needs [20–22]. Projects usually failed because of the cumulative effects of multiple challenges and/or oversights. This implies that E&D projects can withstand some degree of failure whilst still retaining some successful aspects. An example of one of these "mixed bag" projects was revealed through an evaluation of Thailand's subsidised solar battery programme, which found that 60 % of systems were no longer operational at the time of publication. This was attributed to a range of technical and social factors; however, for the 40 % of systems that were operational, users benefitted from quality of life improvements and there were measurable positive effects on children's education [23].

Adding to the complexity of failure is that E&D projects are not static and that outputs and outcomes can vary over time, including beyond the lifetime of the project. This was particularly relevant to micro-hydro projects, which are maintenance-intensive and involve forecasting demand decades into the future [24,25]. In addition to this, projects are vulnerable to shocks completely outside of implementers' control, such as extreme weather conditions [26], devaluation of currency [14], and other competing programmes or technologies [17]. The ability to adapt to these external factors is critical to long-term project success [27].

Whilst mistakes in project planning and implementation do happen - such as solar panels being installed in each other's shadows [26] or health centres being unable to clean their solar systems because they were not provided with ladders [28] - errors that seemed like mistakes were often more nuanced. This was the case for a biogas project in China, where delivery of gas to households was interrupted due to frozen distribution lines in winter. What appeared to be a technical error was in fact rooted in breakdowns in communication and accountability between the village, the provincial project office and the construction company [29]. Poor project management was a disappointingly recurrent theme in the literature, specifically: poor budgeting [26]; unrealistic objective setting [30]; inexperienced project teams [16]; and a lack of adequate funds for post-construction support [24].

The literature also suggests that failure is self-re-enforcing. Not only is poor quality equipment likely to fail, but it can also undermine confidence in the technology, constrain the market and impede demand [16,28,30,31]. Failed energy projects can cast a tarnished legacy on the communities they were intended to serve. This is the case in the town of Bario in Malaysian Borneo, which was the site of multiple renewable energy technology failures, which endure years later and have come to define the town: "*the failure of the mini-hydro power continues to be anecdotally synonymous with Bario itself and visits to the site continue to form part of a standard itinerary among tour guides*" [27, p. 9].

3.1.2. Learning from failure

The literature highlighted instances where the sector is failing to learn from failure. As far back as the 1980s, researchers have mapped the trail of decades' worth of improved stove programmes, which endeavoured to burn biomass more efficiently than their traditional counterparts, and concluded that these stoves had not displaced traditional cooking [32]. Goal displacement, a lack of understanding of user needs, and an absence of monitoring and evaluation (M&E) activities were responsible for billions of dollars being wasted in promoting ineffective technologies. There were also instances of the same errors being made across multiple projects several years apart, such as situating wind turbines in locations with insufficient wind resources, presumably unbeknownst to anyone involved [26,27].

The literature also alludes to the following mechanisms in relation to learning from previous projects:

1. **People**: There were instances where people carried forward learnings and skills acquired through unsuccessful initiatives. This was the case in Kenya with the liquidation of Solar Shamba, the earliest solar home system enterprise. The company left behind people with technical skills that were attributed to helping foster a successful industry in the future [13]. Equally there were other examples of

projects where personnel departure was partially blamed for their failure [28].

2. **Trial and error within programmes**: Whilst it could play an important role in adapting programmes to user needs [22], this costly process could also be minimised if appropriate expertise were engaged in programmes [33] and if errors were properly analysed and understood to be part of the learning process.
3. **Engaging with published best practice**: Best practice guidelines exist for most technologies but project teams are often unaware of their existence [34]. Another way of learning from failure is through the academic literature as evidenced by this review.
4. **Engaging partners and donors with appropriate expertise**: for example, Cambodia's national biogas programme benefitted from previous donor experiences with less successful projects in Asia [35], although a review of multiple case studies of partnerships found that the success of this mechanism is not guaranteed and is strongly dependent on relationships between partners [36].

3.2. Workshops and interviews

Six themes emerged from the discussions in the stakeholder workshops and interviews: 1) defining success and failure; 2) impact of funding; 3) impact of culture; 4) ability to be honest about success and failure; 5) consequences of failing, and 6) what happens to learnings from failed projects. To facilitate reading of the findings, Table 3 shows how the pseudonyms used relate to different groups of participants.

3.2.1. Defining failure

There was consensus that success and failure are not clear-cut in E&D. The challenging nature of projects in this space was repeatedly emphasised and there was a reluctance to use the word 'failure' because of its negative connotations. As one participant explained, "There's a difference between mistakes and tackling complex problems that are difficult to solve" (P4). Participants agreed that there was an important distinction to be made between 'productive failure', which generates new learnings, and 'unproductive failure', which does not. This distinction highlights that failure is not always bad, and that valuable knowledge can be generated from productive failures.

Defining outcomes as successes or failures generally hinges on the definition of appropriate success criteria. For example, is the aim of a project to distribute cooking devices, to identify the barriers that prevent people from adopting them, or to realise the health benefits from long-term adoption? This has an enormous impact on the project outcomes. Another confounding factor is that E&D projects often involve multiple stakeholders who have different agendas and whose objectives do not always align. Therefore, what one partner considers a success could be a failure in the eyes of another. Projects can use indicators (such as the number of people reached) to eliminate this kind of subjectivity, but these quantitative measures can be misleading. A participant example of this was an NGO broadcasting their success in terms of the number of micro-hydro systems installed without disclosing that very few were functional in the field. Actual project impact, as well as the perspectives of intended end-users, can easily be forgotten when success and failure is judged solely against such indicators and donor metrics.

Table 3
Research participants.

Group	Number of informants	Pseudonyms
Group 1: Academics	9	A1, A2, A3, A4, A5, A6, A7, A8, A9
Group 2: Practitioners	8	P1, P2, P3, P4, P5, P6, P7, P8
Group 3: Donors	1	D1

3.2.2. Funding

The above example of dysfunctional micro-hydro systems is typical of the short-term, project-bound funding that is common for the sector. M&E activities are rarely financed or performed effectively. This is problematic because there is a time-based fluidity to success and failure; projects that go wrong can be salvaged and those that go well can fall into disrepair after a period of time. Final results are typically considered to be those at the end of the project's implementation, rather than those after a period of time since the project's end has elapsed. One academic highlighted large, multi-phase research programmes as a solution to this problem. Such multi-year programmes can "allow well established productive working relationships between partners, and can bridge the divides between researchers and practitioners" (A1). They also have the potential to address the absence of long-term M&E through the provision of follow-up funding.

Participants in the academic workshop also reflected on how success is measured by different funders. Success for government funders relates to high-level indicators, such as the number of people brought out of poverty, whereas research funders are primarily interested in traditional academic metrics, such as the number of papers published and citations. Participants found research funders to be more open about failure and flexible in adapting projects as circumstances change.

The practitioners also highlighted that the private sector in E&D is relatively young (less than two decades old), and is seeking to provide products to the lowest income communities. As a result, most companies are currently loss-making, leading to high levels of pressure from investors, whose interests are profit-driven. This can result in a very limited acceptability of failure, with successful projects being cut because they did not contribute to the overall company objective of profitability. Projects can also be terminated in times of donor crisis; several participants had been adversely affected by the reduction in the UK's aid budget, which resulted in large-scale withdrawal of funding and, in some instances, total project failure.

3.2.3. Culture

Participants described how hierarchy greatly influences ability to talk about failure, particularly in academia. Tenured academics with secure contracts may have a more relaxed attitude towards failure than their junior counterparts (A5). This particularly affects people who are marginalised by power (e.g. by gender or minority groups), who tend to be more risk averse and are less able to engage in failing because they fear how it might impact upon their careers.

Private sector organisational attitudes towards failure varied widely, from actively rewarding people who highlight mistakes through to firing those deemed responsible. The latter was associated with the push for profitability in the private sector and was driven by the need to scapegoat when projects go wrong. Such an approach can harm innovation activity, which is often high-risk-high-reward and needs protecting from such commercially-driven decision making. Companies that successfully embrace failure tend to do so at all levels of the organisation and usually have a strong understanding of the objectives they hope to achieve and their associated risks. They have a willingness to learn from failure and structured approaches for feeding learnings back into their work. However, whilst some are open to talking about failure externally, most companies do not support such practices. This is for reasons of confidentiality and the need to demonstrate success to external observers; failure could jeopardise interest from future investors and partners.

There were two other ways that culture affected failure. The first was internal politics of donors. One participant recounted their involvement in a large-scale initiative where obstacles within the institution impeded the project, even though the money was secured: "It was a total failure […] because we were unable to appreciate and navigate the bureaucracy from within" (A7). The second was the influence of local attitudes towards failure, caused by it being dangerous to criticise the government, or because of cultural unacceptability of admitting mistakes. Both these factors lead to there being no conversation about failure and certainly no

published evidence of it.

3.2.4. Honesty

E&D projects are often located in hard-to-reach areas with people whose voices are unlikely to be heard when things go wrong. This, coupled with the widespread use of indicators that do not describe effective impacts, means that "it's easy to dress a project up as a success when actually it didn't impact the community much at all" (A5). Because success stories help attract funding, there are clear incentives to focus more on telling a "good news" story than on understanding and learning from failure. This is underpinned by a perceived lack of realism across the whole international development sector, where the positive impacts of programmes are often exaggerated: "they are into celebrating meaningless success and not really focussing on the important lessons… it has been a disappointment of 30 or 40 years" (A7).

Participants spoke about the difficulties of facing up to failures that they had been involved in. This included accepting that mistakes had been made in implementation and an unwillingness to label projects in such a binary way. One academic reflected on an unsuccessful project they were recently involved in: "We'll probably put a positive spin on it… and say, 'here's how you could do better in the future'" (A3). This dilution of results is particularly common when working in partnerships: "sometimes it's difficult to get to the real crunchy stuff that either party might want to disseminate because you're doing a joint output" (P4). It is easy to hide failure in E&D by blaming the challenging contexts that projects operate in.

3.2.5. Consequences

Failure can have a detrimental impact on current and future projects, especially if funders are not willing to engage in open conversations about it. This was the experience of one participant, who described their exasperation when funding from a large donor was withdrawn because they were being too honest about a project: "you can talk about lessons learned because that's more positive… but if you talk about failure then you're not going to get more funding from the donor" (P1). This is particularly true for government donors, who are under pressure to deliver value for money and face intense scrutiny on the spending of taxpayers' money on overseas aid [37,38]. A donor representative explained that if they fund too many projects that do not deliver on expected outputs then their budgets risk being reduced in subsequent allocation rounds (D1). The external communication of failure in the international development context needs to be handled very carefully, "or the media can easily spin something small into a story about the systemic failure in aid" (D1). Thereby, there is a reputational risk associated with talking about failure that many organisations – and their funders - want to avoid.

One participant also raised an important point about the on-the-ground consequences of labelling a project a failure: "it could reflect negatively on the community… [when] it wasn't their fault" (A1). Others spoke about feelings of guilt when projects fail as they let customers or participants down.

3.2.6. Sharing the learnings from failure

For academics, projects that go to plan are more likely to end up in academic papers. However, this is not always because researchers are reluctant to share failure: it can also be because projects that face lots of difficulties are hard to write up. Conferences, briefing papers and workshops are often used to disseminate learnings that do not make it into journals. Worryingly, but perhaps unsurprisingly, participants gave examples of times when funders had prevented recipients (both practitioners and academics) from publishing about failed projects, even though the results would have been useful to others.

Differences exist between the private sector and the public sector when it comes to sharing. Issues around commercial sensitivity and competition lead to caution in the private sector, although companies will still share some relevant lessons with their partners. With donor funded development projects, the expectation that those learnings will be shared is more common. Even so, and as discussed above, some learnings may be disseminated and discussed only internally rather than written up into external-facing reports, especially in the face of donor reluctance to publish.

There is not always a clear understanding of the reasons why projects failed. This can be due to the absence of post-project support that would otherwise provide the opportunity to capture learnings. It can also be due to the rotation of personnel holding those learnings. One participant observed, "I find this happens a lot, the project closes and then staff just leave if they're tied to that funding too" (P6). By the time absolute failure is reached, those involved want to move on rather than analyse what went wrong, or may have lost their jobs. The consequences of this are severe: "If we continue the same madness, we will continue to get the same failures" (P8).

3.3. Mechanisms

The final part of the workshop focussed on identifying mechanisms for sharing failure. These mechanisms fell into categories defined by the actors or organisations that could implement them. Table 1 of the Supplementary material shows the full list of mechanisms identified, with the full details and comments on advantages and disadvantages. The most important ideas are:

- **Changes to the nature of funding in the E&D space**: A shift away from one-off project funding would build trust and understanding between funders and implementers, giving more opportunity for projects to fail, learn, assimilate and ultimately succeed. This would lead to improved project outcomes and a more open culture; however, it requires structural changes to the way that funding is managed and allocated.
- **Project and research registration**: Research registration is already common practice in other fields, most notably health, where it is mandated by most major funding bodies. This improves research transparency, strengthening the validity and of the scientific evidence base [39]. A database containing basic information about active and completed E&D projects would similarly lend visibility to ongoing work in the sector. It would allow connections to be made between individuals or teams involved in similar projects, thus facilitating peer-to-peer sharing of learnings. Whilst some resistance to provide this kind of information could be expected from certain parties (particularly in the private sector), most E&D organisations benefit from donor money, and those donors may already impose reporting requirements. In this context, transferring this requirement towards a database format would mean aggregating project listing and reporting in one place. Since there are relatively few funders in E&D, there are not many parties that would need to buy into this idea to get good coverage across the sector.
- **Compulsory, open-source reporting on project success and failure**: There is usually a reporting requirement at the end of a donor-funded project. Having a section that forces recipients to reflect on productive failures could assist the process of learning from failure. Making these reports publicly available would allow others to benefit.
- **Creating networks to talk about failure**: These can be intra- or inter-organisational and provide safe spaces where members can talk honestly about failure without fear of negative consequences.

This process highlighted a wealth of ideas about how failure could be shared among academics and practitioners. Many of the mechanisms identified related to creating channels and safe spaces for sharing and disseminating failures. However, it also highlighted that action needs to be multi-level to address the multiplicity of barriers to discussing and sharing failure. We recommend project registration as a valuable and easy-to-mobilise first step towards improving transparency about failure

in E&D.

4. Conceptualising the impact of failure on SDG7

The knowledge accrued through the literature review, workshops and interviews, and discussed above, revealed the complex and elusive nature of failure. It also revealed the many challenges that stakeholders face in discussing and disseminating failed projects and programmes. One of the aims of the projects was to initiate such a discussion, and to highlight the benefits of sharing findings of both successful and failed projects. To facilitate this dialogue, this section pulls together the outcomes of the exploratory research and develops a model to explain the dynamics of failure and the impacts of failure – and the failure to talk about failure – on the delivery of SDG7. Underpinning the model is the distinction between 'productive' and 'unproductive' successes and failures. It is our hope that this model provides a rationale to open up discussion about failure in the E&D space in order to accelerate progress towards SDG7. In order to balance complexity against readability, some important elements, such as the passage of time, have been excluded from the model. Thus, we assume that project objectives are static, but recognise that this is often not the reality, which can distort the way the model classifies projects. It could be argued this results in an overly simplistic depiction of success and failure, but it does have some important implications about the flywheel nature of these two concepts, which are explored in this section. Therefore, we invite other researchers to test and refine the model presented below.

The triangle in Fig. 1 represents an E&D project. This project focus is due to the blurred lines between the work of academics and practitioners in the sector, where E&D researchers are often studying real-world policies or projects rather than conducting lab-based experiments. The apexes of the triangle show three key attributes relevant to its likelihood of success at the outset: how risky the project is ('Risk'); the level of knowledge or experience that those involved have ('Know'); and the level of ambition of its objectives ('Amb'). These attributes interact with each other; a more experienced or knowledgeable team lowers the risk level of the project (this inverse relationship is depicted by the minus sign), which increases the likelihood of progress towards SDG7 (indicated by the green colour of the arrow). Similarly, a more knowledgeable team can afford to be more ambitious, and more ambitious projects are likely to carry more risk. The arrow connecting the 'Amb' apex and the blue circle shows that increasing the ambition of the objectives also increases the project's potential contribution towards SDG7.

Fig. 1 shows four different types of project results. It is important to note that a project is unlikely to fall neatly into one of these categories, and will probably have varying degrees of each:

- **Productive success**: Objectives that link to on-the-ground outcomes are met, resulting in genuine progress towards SDG7. This decreases the perceived risk of future projects by demonstrating positive impacts from investing in E&D. The project is disseminated and the knowledge gained is used by future E&D projects, thus increasing their chances of success too. An example of this is a small, rural hydropower project in rural China which resulted in considerable socioeconomic impacts, including income generation from productive end uses and residents learning to speak mandarin Chinese from their televisions [40].
- **Unproductive success**: Objectives are met but do not link to on-the-ground outcomes, resulting in no real progress towards SDG7. In other words, these projects are 'dressed-up' failures that initially appear successful, but which in fact upon closer inspection, are not. In the short term, unproductive successes may generate the same positive feedback effects as productive successes, with their apparent positive impact encouraging others to follow similar approached. However, in the long term these will become detrimental to the wider sector. This is because unproductive successes use up resources without producing the desired impact, hence increasing the risk level of future projects, and generating misleading knowledge about what works. An example of this is the large-scale improved cookstove programmes of the 1980s, which succeeded in distributing millions of improved stoves, but failed to displace traditional stoves to any extent or reduce deforestation [32].
- **Productive failure**: The project did not achieve its objectives and therefore did not result in direct progress towards SDG7. The consumption of resources without producing any impact or progresses increases the perceived risk of future projects. However, learnings are disseminated, which increases the chances of similar projects succeeding in the future by increasing their level of knowledge – for example, about what not to do. An example of this is a minigrid electric cooking pilot in Nepal, which resulted in an academic paper concluding that widespread adoption of electric cooking in the country is currently unfeasible [41].
- **Unproductive failure**: The project did not achieve its objectives and therefore did not result in direct progress towards SDG7. Failure to produce results increases the perceived of future projects. Lessons are not learned or disseminated, so there is no impact on the starting level of knowledge for future projects. By their very nature, it is hard to find published instances of unproductive failures, although our workshop participants had no shortage of first-hand examples.

Successful projects increase the chances of success for future projects via two pathways: they decrease the perceived risk of the sector; and they produce new knowledge that is useful to future implementers. Similarly, failed projects decrease the chances of success for future

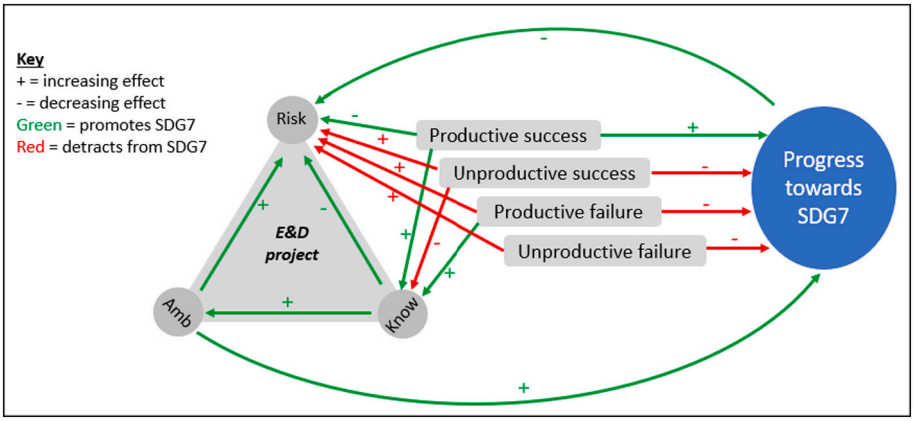

Fig. 1. The dynamics of failure on the E&D ecosystem. (For interpretation of the references to colour in this figure, the reader is referred to the web version of this article.)

projects. They increase perceived risk, making it harder to attract funding. This forces implementers to increase the ambition of their project, which makes the objectives harder to meet. However, if knowledge about failed projects is shared, then future projects can learn from them and thus become more likely to succeed. It is therefore imperative that both productive and unproductive failure is shared so that the E&D sector, and ultimately the E&D community striving to reach SDG7, can benefit.

5. Discussion

This paper has presented the results of an exploratory study into failure in E&D. The research drew on a literature review, workshops and informal interviews; participant anonymisation and the use of Chatham House rules were critical in having open and honest conversations about this difficult topic. These conversations led to the development of a model to capture the dynamics of productive and unproductive successes and failures and the outcomes for SDG7.

The research revealed that success and failure in E&D are not clear-cut and are usually defined relative to project objectives and indicators. This is problematic when objectives become decoupled from on-the-ground outcomes for end users, and can lead to projects that appear successful but actually contribute little towards meeting SDG7 –the 'unproductive' successes referred to in Fig. 1. A further confounding factor is that a project's legacy is dynamic and varies over time. Long-term project support is essential in delivering successful projects but rarely occurs, mainly due to the lack of funding and reluctance from funders to support long-term M&E.

Workshop participants expressed reluctance to use the word 'failure'. This seemed to be reflected in the low number of publications brought forward by the literature review; people preferred to label projects as 'unsustainable' and to use softer language such as 'barriers' and 'challenges'. However, the root cause of failure is rarely a mistake, and most, if not all, projects generate valuable learnings, even if they are small. There is therefore a key difference between 'productive failure', where this knowledge is assimilated and shared, and 'unproductive failure', where it is not. We believe this distinction could help change attitudes towards failure by providing a common understanding of the benefits that sharing failure delivers.

The research identified several active mechanisms for learning from and sharing failure in E&D, which included knowledge transfer through individual experiences; trial and error within programmes; engaging with published best practice; and appointing partners with appropriate expertise. The workshops revealed additional mechanisms that, if implemented, would help to break the stigma around sharing failures. Whilst we recognise the challenges of initiating change in a sector that involves so many actors and institutions, we believe a feasible first step would be to create a project registry for E&D that would, at the very least, increase project visibility.

There were also some notable differences between the literature review and the workshops. The academic literature had a focus on diagnosing the root causes of failure and drawing out generalised learnings from individual cases. It revealed how failure can harm the reputations of technologies and have detrimental impacts on local markets, and documented instances of the sector's failure to learn from failure. By contrast, the workshops focussed on the reasons why we do not talk about (or publish) failure, and gave an insight into the pressures experienced by those working in E&D. They revealed the tensions between funders (whether donors or investors) and those trying to deliver projects, and how these can lead to an intolerance of failure. This can manifest as job losses, scapegoating or suppression of negative results.

Workshop participants also discussed the important role of organisational culture in allowing people to talk about failure and how much this varied between organisations. Barriers included the role of hierarchy in academia, pressure to achieve profitability in the private sector, and even the fear of losing one's job. They also reflected on the consequences of failure, such as reduced chances of winning future funding and reputational damage. Telling success stories, on the other hand, attracts more funding and bolsters credibility. This leads to the suppression of failures and the amplification of successes. In turn, this contributes to reinforcing unrealistic expectations across the sector, and pressurises stakeholders to misrepresent reality by celebrating unproductive successes. This agrees with the findings of a 2014 review of UK-government funded private sector development projects, which reported that the pressure to demonstrate results against indicators provided incentives to greatly overstate impact, leading to objectives that are "excessively ambitious and fail to reflect what is possible" [42].

We recommend several strands of future research that would aid the understanding of failure in E&D and help normalise discussions around it. This could start with a more rigorous literature review that includes grey literature sources and wider search terms. Investigating how failure affects more nuanced stakeholder types (e.g. NGOs versus private-sector practitioners, public donors versus private-sector investors, public-private partnerships, academics at different stages of their careers) would help identify more specific interventions to highlight and reduce the stigma that each group typically associates with failure. Applying our framework to analyse projects – possibly in combination with other, more established models – could test its validity, tease out hidden learnings and gather evidence about the impact of different types of success and failure on SDG7 (particularly the arrows that we describe as feeding the flywheel). Doing so across a range of case studies could generate useful insights about critical success factors for different project and technology types.

Finally, and most importantly, we propose that future work focusses on realising the mechanisms we identified for sharing failures in E&D. Our research suggests there is an on-the-ground appetite for addressing the taboo of failure in this sector; we believe a simultaneous top-down approach will accelerate change. Therefore, there is a need to engage over-arching sector bodies and funders in these important conversations (e.g. SE4All, the World Bank).

6. Conclusions

Projects, policies and programmes in E&D face a unique set of challenges resulting in a relatively high likelihood of failure. The lessons learned from these unsuccessful endeavours are often not captured and formal dissemination is rare. Important contributing factors towards these omissions include the nature of funding in the sector, which is often short-term and encourages the amplification of success, organisational culture, fear of reputational damage and the lack of obligation to report results.

The role of failure in E&D projects is multidimensional. It intrinsically hinders progress towards SDG7 by using resources without producing desired impacts. It can decrease future projects' chances of success by increasing the perceived risk of activities in the sector. However, failure generates new knowledge and important learnings, and if these are shared then they can increase the chance of future projects being successful. Such "productive failures" consist of projects that did not meet their objectives, but assimilate and share their learnings. We have also identified key mechanisms which will facilitate the sharing of these productive failures: structural changes to the nature of funding in the E&D space; the creation of a project and research registration database; compulsory open-source reporting on failure; and creating networks that support openness about failure.

The intent of this work was exploratory and aimed to stimulate a dialogue on failure in E&D that we felt was peculiarly absent. As we conducted our research, we encountered a strong appetite from practitioners, academics and funders alike for a fundamental shift towards more openness within the sector. With 2030 fast approaching, we believe this change is urgently needed in order to achieve SDG7's ambitious - but critical - targets.

Declaration of competing interest

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Data availability

The data that has been used is confidential.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.erss.2022.102804.

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