Journal of Responsible Technology 20 (2024) 100094

Contents lists available at ScienceDirect

Journal of Responsible Technology

journal homepage: www.sciencedirect.com/journal/journal-of-responsible-technology

Research Article

Start doing the right thing: Indicators for socially responsible start-ups and investors

Mark Ryan [a,*], Eugen Popa [a], Vincent Blok [a], Andrea Declich [b], Maresa Berliri [b], Alfonso Alfonsi [b], Simeon Veloudis [c], Natalia Costanzo [d], Martina Iannuzzi [d]

[a] *Philosophy Department, Wageningen University & Research, the Netherlands*
[b] *Knowledge & Innovation, Italy*
[c] *SEERC, Greece*
[d] *EBAN, Belgium*

ARTICLE INFO

Keywords:
Responsible research and innovation
Socially-responsible investment
Start-ups
Indicators
Business ethics

ABSTRACT

This paper explores the gap in the literature on social responsibility guidance for start-ups and start-up investors. It begins by evaluating research conducted in two different fields (namely, socially responsible investment (SRI) and responsible research and innovation (RRI)) and how they can guide social responsibility in STEM (Science, Technology, Engineering, Mathematics) start-ups. To do this, we evaluate an industry-standard SRI catalogue of metrics - the Global Impact Investing Network's (GIIN) *Impact Reporting and Investment Standards* (IRIS+) - and indicators from 12 EC-funded RRI projects. Based on this analysis, we propose a framework of 24 indicators to assess the social responsibility of start-ups and investors. The purpose of our framework is twofold: firstly, to provide clear guidance for start-ups aiming to implement socially responsible behaviours, and secondly, to provide start-up investors with criteria to identify if start-ups are socially responsible. While the indicators are phrased in a prescriptive way for start-ups, they can also be used by investors to identify if start-ups are implementing the indicators in practice.

1. Introduction

One of the biggest challenges for impact investors is identifying what innovations will result in a return on investment whilst lining up with one's ideals (Blok, Tempels, Pietersma, & Jansen, 2017; Widyawati, 2020). As a result, many efforts have been made to ensure a better linkage between investment and social responsibility and to help clarify this linkage for impact investors. Many terms have been coined to designate this move to incorporate social responsibility in investment (OECD, 2022); for example: "social investing/finance", "ethical investing", "value-based investment", "environmental, social, and governance (ESG) investment", and "impact investing"[1] (Losse & Geissdoerfer, 2021; Widyawati, 2020). This paper will refer to this diverse literature under the umbrella term "socially responsible investment" (SRI).

SRI strives to align *shareholder value*, focusing predominantly on economic benefit, with the broader-based *stakeholder value* that incorporates, in addition to financial gains, an optimum level of return for organisational stakeholders, i.e., for entities that are potentially affected by an organisation or who have a vested interest in ESG issues, e.g., citizens, societal/political/environmental organisations, research institutes, and media. It commonly does so through a screening process based on ESG indicators (Gangi & Varrone, 2018) that "goes beyond minimising harmful outcomes to actively creating good ones by creating a positive impact" (Cohen, 2020, p. 17). This screening occurs before and during investment and forms a central tool for implementing SRI (Gangi & Varrone, 2018). Nevertheless, "SRI indicators", despite their

* Corresponding author.
E-mail addresses: mark.ryan@wur.nl (M. Ryan), eugen.popa@wur.nl (E. Popa), vincent.blok@wur.nl (V. Blok), andrea.declich@knowledge-innovation.org (A. Declich), berliri@knowledge-innovation.org (M. Berliri), alfonsi@knowledge-innovation.org (A. Alfonsi), sveloudis@seerc.org (S. Veloudis), natalia@eban.org (N. Costanzo), martina@eban.org (M. Iannuzzi).

[1] 1. We note here that "impact investing" has a materially different scope than the other terms (Koenigsmarck & Geissdoerfer 2023): impact investing considers profitability subordinate to the intended societal or environmental impact, as opposed to socially responsible investing where standard return expectations on investments apply; moreover, impact investors are typically interested in a higher stake of equity that grants them greater control over the target organisation's management (Eurosif, 2018), whereas socially responsible investors are usually interested in minor stakes (Roundy et al., 2017).

https://doi.org/10.1016/j.jrt.2024.100094

Available online 27 September 2024

considerable diversity[2] (Koenigsmarck & Geissdoerfer 2023), are primarily targeted at large and mature organisations, failing to consider the distinctive characteristics of start-ups, particularly STEM (Science, Technology, Engineering, Mathematics) start-ups[3] (i.e., their typically small composition, their dynamic nature, their fluid intra-organisational roles, their extensive dependence on the external environment for securing access to resources such as funding, mentoring, or feedback in Minimum Viable Product (MVP) cycles, and crucially, their extensive exposure to research and development (RD) effort). Therefore, SRI indicators should be supplemented with another approach that can overcome some of these challenges. It needs support from an approach with a much stronger emphasis on broader stakeholder engagement and social responsibility in a context where RD - and its uncertainties - is a primary concern.

One such approach that may help in this regard is the responsible research and innovation (RRI) approach first developed by the European Union (EU) in 2010 to incorporate more responsible practices and behaviours into European-funded research. RRI is a reflexive approach focused on the ethical and societal implications of research and innovation activities, giving greater weight to the normative reasons for investment and largely ignoring instrumental ones. The four fundamental process requirements of RRI are *anticipation*, first- and second-order *reflexivity, inclusive deliberation* with the public and stakeholders, and *responsiveness* in shaping innovation agendas and trajectories (Owen et al., 2013; Stilgoe, Owen and Macnaghten, 2013).

However, the main bulk of RRI literature (e.g., Lehoux et al., 2021; Ryan, Mejlgaard, & Degn, 2021; Van De Poel et al., 2020; Owen, von Schomberg, & Macnaghten, 2021; Stahl et al., 2017) focuses on strategies, guidelines, and objectives for RRI in research performing and funding organisations (RFPOs) .[4] Although there has lately been significant progress toward greater incorporation of *industrial* RRI, yielding a growing body of RRI indicators for industry (see, for example, Long and Blok, 2018; Blok & Lemmens, 2015; and Nazarko, 2019), these are again aimed at more mature businesses (except for the works in Long, Blok, Dorrestijn, and Macnaghten (2020)).

This paper is the result of research conducted in the RRIstart project (https://rristart.eu/). In our research in this project, we propose operationalising social responsibility in STEM start-ups by cross-fertilising SRI and RRI indicators. This paper synthesises SRI and RRI and develops a set of indicators for STEM start-ups and start-up investors. We demonstrate that SRI and RRI can complementarily guide social responsibility and investment in start-ups. On the one hand, SRI strongly focuses on industry requirements for success, while RRI provides precise requirements to ensure social responsibility in the start-up innovation process.

The paper is structured as follows: Section 2 consults academic literature to define a STEM start-up, start-up investors, and current research on SRI and RRI indicators. Section 3 provides an outline of our methodology for evaluating currently existing indicators, implementing exclusion criteria, and formulating a revised set of indicators for start-ups and investors in start-ups. For this, we evaluate an industry-standard SRI catalogue of metrics (the Global Impact Investing Network's (GIIN) *Impact Reporting and Investment Standards* (IRIS+)) and RRI indicators retrieved from 12 EC-funded RRI projects. After indicator identification, exclusion, and refinement, this resulted in a list of 24 indicators (Section 4). These indicators have a dual function: firstly, to provide clear indicators for start-ups aiming to implement socially responsible behaviours, and secondly, to provide investors with a list of criteria to evaluate the social responsibility of start-ups they want to invest in. Section 5 demonstrates how the 24 indicators can be correlated with and provide operationalisation to scientific research in responsible innovation (e.g., the four AIRR process requirements (anticipation, inclusion, reflexivity, and responsiveness) outlined by Owen et al., 2013) and also how they could be adapted for discussions in more extensive research projects (e.g., the six EC RRI keys (European Commission, 2021)).

Overall, this paper will provide a preliminary list of usable indicators for start-ups and investors in start-ups to begin discussions on how to implement social responsibility in practice. They are meant to initiate discussions, further research, and implementation in research projects and respond to a clear gap in the field for clear implementable guidelines for social responsibility in start-ups and start-up investors.

2. Social responsibility indicators for start-ups

Social responsibility refers to individuals' and organisations' positive and negative responsibility toward society. It refers to the moral responsibility to benefit the community, avoid harm, and actively pursue actions that lead to positive societal outcomes. This paper primarily refers to social responsibility in the context of commercial applications (e.g., start-ups). It focuses on an organisation's responsibility for ensuring that their actions and products do not cause harm (e.g., toward the environment, their employees, and society as a whole) and that their actions and products positively contribute to these stakeholders. For example, this could be achieved through fair and respectable employment conditions, sustainable use of resources, and contributions to charitable causes, to name but a few. However, before we begin, we would first like to describe the two main actors we will discuss in this paper concerning social responsibility: start-ups and investors in start-ups.

2.1. Start-ups

When we refer to a start-up, we describe a company as a very early initiative from one or more entrepreneurs to develop a business idea (the so-called "entrepreneurship nexus" - see Shane and Venkataraman 2000). It is the formation of an organisation based on the conception of a new venture idea and, in general, the definition of a business opportunity (Davidsson, 2015). Our literature analysis has led us to formulate four characteristics of a start-up generally and a fifth characteristic that distinguishes a STEM start-up from other start-ups.

First, in most cases, the entrepreneur(s) of the start-up is(are) also the manager(s), staff, administration, and finance. Entrepreneurs wear many hats in their roles, and the start-up is very fluid with individuals' roles, titles, and functions (Long et al., 2020;Henriques & Öberg, 2016). In the working environment of a start-up (Quaranta & Mastropietro, 2003; Stamm & Gutzeit, 2021; Stamm, Cruz, & Cailluet, 2019), employees do not typically fall within standard organisational categories that commonly apply to regular-sized organisations, and the standard difference between manager and subordinate is not prominent (Long et al., 2020; Henriques & Öberg, 2016; Retolaza, Ruiz, & San-Jose, 2009).

Second, start-ups are usually quite specialised in their products. The target audience is relatively small in comparison to more mature businesses, which means fewer resources and opportunities to focus on everything the entrepreneurs would like to (Maccarrone & Contri, 2021; Long et al., 2020; Henriques & Öberg, 2016; Retolaza, Ruiz, & San-Jose, 2009). Subsequently, they also have fewer resources and capacity to implement social responsibility as a more mature business; thus, they strongly depend on investors.

Third, start-ups often have less control over many aspects that may help or hinder their product's design as a mature business. This lack of control and ambiguity creates high uncertainty about the product's

[2] A diversity that perhaps reflects the subjectivity that characterises SRI: "what is considered to be SRI by one market participant might not be fully recognized by another" (Widyawati, 2020, p. 623).

[3] I.e., companies that are founded based on innovations (products or services) rooted in the fields of Science, Technology, Engineering, and Mathematics.

[4] Typically, academic institutions or non-profit research centres.

potential success or failure (Long et al., 2020; Henriques & Öberg, 2016; Retolaza, Ruiz, & San-Jose, 2009). This ambivalence in the organisation makes it difficult to care about things that are not seen as essential to the economic success of the start-up (e.g., social responsibility). The start-up development and innovation process is not linear and highly intertwined, and the output is unclear.

Fourth, because of their early stage of development, start-ups often typically lack stakeholders (including investors); instead, they (mainly) depend on anticipated stakeholders (Retolaza, Ruiz, & San-Jose, 2009; Voinea, Logger, Rauf, & Roijakkers, 2019). This reliance makes it challenging to implement social responsibility towards stakeholders who do not yet exist and who may never exist if the business is unsuccessful.

The fifth characteristic is the only one that distinguishes a *STEM* start-up from other start-ups. This characteristic is that they are highly dependent upon RD activity and thus require a (typically small) network of highly skilled employees in STEM fields to pioneer the success of their products (Long et al., 2020; Henriques & Öberg, 2016; Retolaza, Ruiz, & San-Jose, 2009). Employee selection occurs from a much smaller pool of individuals than in a larger organisation that may be biased and not adequately include marginalised groups. In that case, it will be more challenging to ensure a diversity balance in the workplace, despite the start-up wanting to take proactive steps to counter and change the biased system they are a part of.

It must be noted that this paper focuses specifically on STEM (Science, Technology, Engineering, and Mathematics) start-ups. The reason for this is that STEM start-ups are (usually) high-tech (because of the implicit nature of STEM) and tend to, and are likely to, have significant societal impacts (this is not to say that non-STEM start-ups do not also have significant impacts) (Ryan et al., 2023). There is a clear need and importance for STEM start-ups to implement social responsibility because of the potentially high societal impact that they will have (Ryan et al., 2023). This need does not imply that non-STEM start-ups will not also require social responsibility. Instead, we state that it is crucial to specifically analyse STEM start-ups because of their potentially high disruptive nature (Ryan et al., 2023). For conciseness, we will refer to 'start-ups' for the remainder of the paper, but we are referring to STEM start-ups. However, much of our findings are also applicable to non-STEM start-ups.

2.2. Start-up investors

Investors caring about the social responsibility of a start-up must be distinguished from traditional venture capitalists, who typically do not invest in these types of start-ups because they view them as having lower growth potential and economic reward (Fichter & Olteanu, 2019) or because they are higher risk than other types of start-ups (Cumming, Henriques, & Sadorsky, 2016; Kortenhorst & Kortenhorst, 2017): 'tVCs [traditional venture capitalists] do not integrate sustainability into their justification and, therefore, also not into their decision-making even when investing in sustainable ventures' (Wöhler & Haase, 2022, p. 7).

In addition, there is a concern on behalf of the socially responsible start-up that an investor may cause 'mission drift' (Cornforth, 2014). Mission drift is when the start-up's goals are watered down or changed to suit the values of their investors, i.e., their mission drifts off-course (Cornforth, 2014). Therefore, some researchers promote the idea that socially responsible start-ups should encourage investment from "green" investors instead of traditional venture capitalists (Bergset & Fichter, 2015). However, in reality, this is often quite difficult to achieve because the real intent and values of the investor may not always be clear. For example, social responsibility may be a secondary goal (after increased profits), and investment in the start-up is just another way to obtain more capital (Bocken, 2015).

Regardless of the intent of the investor, start-ups that wish to have positive societal impacts in their business need to also ensure that their business is economically sound. By having a balance of both, they have greater chance of investment (regardless of the investor's primary intent) because an investor would not be detracted by the lack of economic benefit from investing or from a lack of societal impact from investing in the start-up. Therefore, start-ups must focus on their business *and* social impacts, or what Garst, Blok, Branzei, Jansen, and Omta (2019) call 'double materiality'. Double materiality considers the materiality of the business case perspective (when SRI impacts the company's financial performance) with the societal impact perspective (namely, when SRI topics reflect the economic, environmental, or social impact of the company on society). Companies should consider both perspectives in their business decisions, something also advocated by the European Commission (EC) (European Commission, 2021).

Start-ups should achieve this double materiality in win-win scenarios (Garst et al., 2019, p. 83), where the business case and societal perspectives are mutually compatible and beneficial. However, it is often difficult for investors to identify the social responsibility of a start-up, their ambitions for implementing social responsibility, and ways to evaluate a start-up's social responsibility in practice. In response to this, efforts have been made to provide clarity to investors through the IRIS+ catalogue of metrics.

2.3. SRI indicators: the IRIS+ catalogue of metrics

Several approaches to defining organisational-level indicators have been proposed (Searcy, 2012; Barrett, 2001; López, Garcia, & Rodriguez, 2007; Shank, Manullang, & Hill, 2005; Spangenberg, 2016; Veleva & Ellenbecker, 2001). In addition, many SRI data providers like Inrate, I.S.S. oekom, MSCI ESG Research, Refinitiv, Sustainalytics, Moody's ESG Data, Bloomberg ESG Data, and RepRisk provide their indicators. The most comprehensive example of SRI indicators is provided by the Global Impact Investing Network[5] (GIIN) *Impact Reporting and Investment Standards* (or 'IRIS', also known as 'IRIS+' since 2019). IRIS+ currently offers 685 indicators that can be traced back to the idea that mission-driven enterprises need an effective and consistent way to articulate their social and environmental performance to establish credibility, enable peer comparisons, and effectively raise funds among the growing set of investors seeking social and environmental returns alongside financial profits (Bouri, 2011, p. 116; and Wevers & Voinea, 2021). IRIS+ resulted from a broad stakeholder consultation process and is aligned with the fundamental principles governing SRI, such as the Sustainable Development Goals (SDGs), and other diffused impact assessment tools, such as the B Impact Assessment.[6] None of the 'Core Characteristics' that function as the methodological basis for IRIS+ restrict its usage to any particular industry.[7]

A significant function of IRIS+ is the provision of unified metrics applicable across organisations and fields of application. These indicators focus on measuring investment's social and environmental outcomes. In that sense, IRIS+ functions "like a dictionary", meaning that it provides "clear and consistent definitions for terms commonly used to describe social, environmental, and financial performance" (Bouri, 2011, p. 121). IRIS+ crucially embodies a particular theory about what SRI should look like through its selection of indicators. IRIS+ outlines what it means to incorporate social impact into (or alongside) financial return on investment.

However, because of the small size, changing roles, and fluid dynamics in a start-up, it becomes challenging to implement IRIS+ indicators in a start-up. For example, indicators such as the number of women in managerial positions or the number of people with a disability with full-time contracts that are commonly used in SRI assessments (see, for example, IRIS+ or B Impact Assessment framework[8]) might not only

[5] Founded in 2009 by the Rockefeller Foundation, Acumen Fund, and B Lab.
[6] https://www.bcorporation.net/
[7] See https://thegiin.org/assets/Core%20Characteristics_webfile.pdf
[8] https://www.bcorporation.net

score exceedingly low or high relative to regular-sized organisations but also be challenging to assess because the same individual might navigate various positions within the start-up. Generally, due to the typically small size of start-ups, statistical frequencies and percentages may not be suitable instruments, resulting in *statistical bias and misleading information* about the start-up (Alvord, Brown, & Letts, 2004; Arena, Bengo, Calderini, & Chiodo, 2018; Tracey & Stott, 2017.

While the IRIS+ metrics are effective for *mature* businesses, they are often too complex for many start-ups to implement (Long et al., 2020) because they focus less on social responsibility in an RD context. Start-ups need more support from social responsibility-focused indicators (such as RRI) to implement socially responsible business practices.

2.4. RRI indicators: AIRR process requirements and EC RRI keys

The field of RRI emerged circa 2010 as a response from the European Union (EU) to incorporate more responsible practices and behaviours into European-funded research. According to Von Schomberg (2012), RRI is '*a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (to allow a proper embedding of scientific and technological advances in our society)*'. Mutual responsiveness naturally entails an *alignment* between the research and innovation (R&I) process and its outcomes on the one hand and societal values, needs and expectations on the other. This alignment can only be achieved through a complex interactivity framework and multidimensional knowledge exchange.

In the last decade, many different models of RRI have been put forward (Asveld, 2017; Koops et al., 2015; van den Hoven, Swierstra, Koops, & Romijn, 2014). The approach by Owen et al. (2013), in particular, has proven to be a cornerstone for the RRI field. The four-point process requirements, commonly referred to as AIRR (anticipation, inclusion, reflexivity, and responsiveness) of RRI are:

- *Anticipation* provides questions about the impact of specific scientific research and technological developments on society and the environment. It examines the certainties and uncertainties during these activities to postulate the potential consequences of such actions and behaviours.
- *Inclusion* brings together the main stakeholders affected by a case, providing them with the power to bring about change while providing scientists and innovators with the views of their stakeholders.
- *Reflexivity* is a process in which researchers focus on potential impacts and how this may affect certain positions, frameworks, approaches, and cultures.
- *Responsiveness* is the implementation of appropriate actions based on the results from the earlier three process requirements.

Nevertheless, such broad conceptualisations do not provide concrete information about how organisations, including firms and start-ups, could or should implement RRI (as criticised by the EC). As a result, the EC created the six RRI keys, which promote and pair scientific excellence with social awareness and responsibility (European Commission, 2021): (1) public engagement and participation of societal actors in the entire span of the R&I process; (2) science literacy and scientific education; (3) gender equality in research and innovation; (4) open access to scientific knowledge; (5) ethics focusing on research integrity and the ethical acceptability of scientific and technological developments; (6) robust, adaptable and inclusive governance arrangements to pursue, or further, the other five keys. The EC assumes that if businesses implement RRI practices, the end product is more likely to be accepted, reducing the risk of rejection (Frenken, 2014) and improving the firm's reputation (PRISMA, 2019).

Overall, RRI has become a research focus in large projects funded by the EC (in particular, Horizon 2020). Many projects have somehow dealt with responsible innovation in the industry, but these have generally adopted diverse perspectives and approaches[9] and completely ignored start-ups. Most of these projects focus on implementing the RRI's six keys in RFPOs by promoting institutional change towards gender equality and open access.

Some research has already been conducted to show how RRI indicators can be aligned with organisational/business indicators and the need to stimulate RRI uptake in practice (Kwee et al., 2021). However, because there is no unifying set of indicators that one can use, it is not easy to provide specific solutions to the challenge of measuring social responsibility in start-ups. Therefore, one needs to examine multiple projects and reports within the field of RRI to identify such indicators. In addition, RRI indicators need the support of a more business-focused set of indicators, such as the IRIS+ catalogue of indicators, because investment needs to be economically beneficial and socially responsible for investors in start-ups.

2.5. Indicators for social responsibility

Many in the field question metrics' sense (or even nonsense) for capturing social responsibility (e.g., Chatterji, Levine, & Toffel, 2009; Scalet & Kelly, 2010). There are limitations in measuring social responsibility solely in numbers or metrics, ranging from fudging the numbers and details to making it appear that the company is doing better than they are. Companies may also focus only on the metrics they are accounting for while overlooking all of their other social responsibility not captured in the metrics. Furthermore, there is the potential that companies will use their abidance by specific metrics as a way of greenwashing or ethics-washing (i.e., making incorrect or misleading statements about their environmental or social responsibility activities). There is also the possibility that organisations will only focus on the negative harms (i.e., things to avoid or prevent) while overlooking their positive duties (i.e., their proactive and responsive actions).

'Prescriptive indicators' may be a way to overcome some of these concerns (see Meijer & van de Klippe, 2020; Shelley-Egan, Gjefsen, & Nydal, 2020). The use of prescriptive indicators may be beneficial to form and consolidate start-ups' entrepreneurial groups, identify economic opportunities, and define an innovative production process with idiosyncratic aspects (Ryan et al., 2023). They can provide directions (that start-ups should interpret according to their points of view) more than defining specific goals that may not be appropriate for that particular organisation or its situation.

Prescriptive indicators also measure positive duties, what companies should be actively pursuing, and what investors should concentrate on when investing in socially responsible start-ups. Indicators can also be helpful for start-ups to communicate with investors, demonstrating their social responsibility and what investors can expect when they invest in the company. Furthermore, investors can use indicators to determine what type of start-up they want to invest in (Wöhler & Haase, 2022). Prescriptive indicators may help start-ups and investors find the right match between them.

[9] They ranged from RRI in marine and maritime research (GRRIP project), RRI and children as agents of change in Europe (SiS Catalyst project), the role of RRI in neuro-enhancement research (NERRI project), RRI in synthetic biology (SYNENERGENE project), and how to involve students and the public in RRI (IRRESISTIBLE project).

Table 1
The 12 RRI Projects analysed.

Name of method or deliverable	Leading organisation	Objective(s)
GREAT – Governance for Responsible Innovation (2016) https://www.great-project.eu/	University of Namur (Belgium)	To develop a model for governance in RRI, especially from a multi-stakeholder and policy perspective.
Responsible Innovation COMPASS (2019) https://innovation-compass.eu/	Wien University (Austria), Institute for Managing Sustainability	To develop Compass Self-check, a specialised RRI assessment tool tailored to the needs of SMEs.
ProGReSS RRI Funder Requirements Matrix, Best Practices of RRI in Industry https://www.progressproject.eu/	University of Central Lancashire (United Kingdom), Center on Ethics	To compare the strategies of funding research organisations, using RRI criteria for assessing research proposals for ethical acceptability, sustainability and social desirability
Framework for Responsible Research and Innovation in ICT – ORBIT (2022) https://www.orbit-rri.org/	Engineering and Physical Sciences Research Council (EPSRC)	To assess the embedment of RRI in products and ICT organisations' research and innovation process.
Assessing Open Access in Industries – ON-MERRIT (2022) https://on-merrit.eu/	Know-Center GmbH (Austria)	To investigate practices towards seeking and using research information and data for innovation and how they benefit from Open Access.
Knowledge Acceleration and Responsible Innovation Meta-Network – KARIM (2018) https://www.nweurope.eu/	Centre Francilien de l'Innovation (FR)	To develop an RRI guide for enterprises to diagnose their business model, develop new products, services, and technologies, or even improve their production processes based on social, economic, and environmental impacts.
Responsible Open Science in Europe (ROSIE) Self-assessment questionnaire (2017) UNI/PDR 27–2017 Guidelines for the responsible innovation management and development process (2017) https://www.interreg-central.eu/	CISE, *Centro per l'Innovazione e lo Sviluppo Economico*, Special Agency of the Chamber of Commerce of Forlì-Cesena	To innovate responsibly, develop guidelines and standards applicable to all stages of an SME life cycle. It includes an assessment of the maturity of the local innovation policy framework and ecosystem.
MULTI-ACT Master Scorecard (2021) https://toolbox.multiact.eu/multi-act-manual#_Toc70265315	Italian Multiple Sclerosis Society Foundation (FISM)	To provide a new tool to assess the value of research in increasing the positive impact of health research on patients.
START HEATMAP EUROPE (2022) https://www.startupheatmap.eu/	Deep Ecosystems (Germany)	To develop a self-check guide to help ecosystem builders by providing validated insights into the degree to which an entrepreneurial ecosystem is on the right track to achieve systemic growth and development.
New HoRRIzon (2021) https://newhorrizon.eu/	Institute for Advanced Studies (Austria)	To develop a self-assessment tool to guide research projects and early-stage companies in structuring their internal processes to efficiently operationalise RRI principles in their daily activities.
PRISMA (2019) https://www.rri-prisma.eu	Delft University of Technology (TUD)	To develop a roadmap that will help companies institutionalise RRI.
Responsible Industry Project (2017) http://www.responsible-industry.eu/	De Montfort University, Leicester (UK)	To demonstrate how the industry can work with societal actors to integrate principles and methodologies of RRI into research and development processes.

Because of these reasons, our paper provides prescriptive indicators that suggest practices that should be followed or behaviours that should be adopted. These prescriptive indicators outline what a start-up should focus on when pursuing social responsibility.[10] The choice of indicators of this type is due mainly to the nature of start-ups, i.e., they are "nascent" actors who define their main features depending on how the process evolves. The indicators are also qualitative since they do not imply the measurement of certain characteristics of a phenomenon but the occurrence of specific practices conducive to the responsibility (e.g. the use of sustainable materials by start-ups).

3. Methodology

The methodology implemented in this paper was carried out on two samples: the IRIS+ catalogue of 685 metrics and identified indicators from 12 RRI EC projects' reports.

Firstly, the IRIS+ *Catalogue of Metrics* is a comprehensive repository of 685 metrics (at the time of this research) compiled and categorised in various ways for individual use (see Appendix 1 for an overview of the organisation of these metrics). The IRIS+ catalogue of metrics is applicable to impact investors. No restrictions regarding its application are mentioned in the 'core characteristics' that are the methodological basis for using these metrics.[11] IRIS+ promotes an important distinction between impact investment indicators that pertain to a specific industry (or sector) and those that apply to all sectors, the so-called 'cross-category' indicators (see Appendix 2).[12]

Secondly, we carried out a scoping review of the documents

[10] Also, the literature on RRI has been focused since the beginning also on measuring the attainment of social responsibility (see the MORRI project, Stilgoe 2018; Wickson and Carew 2014; Yaghmaei and Poel 2021). This effort was focused not just on research organizations but also on companies (Lubberink et al. 2017, also through qualitative indicators Porcari et al 2020).

[11] See https://thegiin.org/assets/Core%20Characteristics_webfile.pdf

[12] The cross-categorical indicators constitute over half of the IRIS+ catalogue of metrics. Although the category-specific indicators and the cross-category indicators are typically used in combination, it is important to note that the cross-category indicators are meant to be generally applicable, while category-specific ones are to be taken into consideration only when a firm is active in those relevant sectors. For example, the indicator PD6363 species extension threat which "describes applicable threats to species during the reporting period" is a specific indicator of the category of biodiversity. It is only applicable if the firm is active in that sector or impacts biodiversity. By contrast, a cross-category indicator such as FP3774 charitable donations which captures the "value of all financial contributions and in-kind donations of goods and services made by the organisation to charities, private foundations, non-profit organisations, or non-governmental organisations during the reporting period" is applicable regardless of what sector a company is in.

Table 2
Exclusion criteria for evaluating the RRI indicators and IRIS+ catalogue.

Exclusion criteria for evaluating the IRIS+ catalogue of metrics and for RRI projects
The indicator was not relevant for start-ups. For example:
i. It would result in statistical bias and misleading information.
ii. It is too difficult to source representative information.
iii. It is too difficult to implement because of the size/structure of a start-up.
The indicator does not provide operationalisable guidance for start-ups.
i. The indicator does not focus on issues of social responsibility.
ii. The indicator does not focus on issues related to the application of RRI to enterprises (*only significant for the RRI indicators*).

produced by relevant RRI projects.[13] We identified 78 projects focusing on RRI in business, but this was narrowed down to 12 projects that provide tangible indicators for how companies (and, possibly, start-ups) should implement RRI (see Table 1).

3.1. Exclusion criteria for indicator identification

We analysed documents from these 12 projects to understand the kinds of RRI indicators they use and whether these are relevant for start-ups. We also analysed the IRIS+ catalogue of metrics to identify suitable indicators for assessing social responsibility in start-ups. Both analyses were performed based on the exclusion criteria shown in Table 2.

The first exclusion criterion came from the challenges of implementing indicators to start-ups, as listed in Section 2 (i.e., small size, fluid working environment and small network of highly skilled employees). Exclusion criterion two was established because indicators must be clear and readily implementable. Exclusion criterion three was established based on common criticisms against SRI indicators (i.e., they do not focus on social responsibility enough) and RRI indicators (i.e., they only focus on research and EC projects, not on industry/enterprise). 3.i. was applied more so to the IRIS+ catalogue of metrics, and 3.ii. more so to the 12 RRI project documents.

3.1.1. Exclusion criteria applied to the 685 IRIS+ catalogue of metrics

When applying the exclusion criteria listed in Table 2 to the IRIS+ catalogue, many of the metrics were unusable for start-ups or investors in start-ups. For example, when we applied exclusion criterion 1.i., many indicators in the IRIS+ catalogue would lead to statistical bias against a start-up. For example, while a start-up must consider minorities and previously excluded groups, indicators in the catalogue of metrics that focus on equal pay relative to a "specified position" could lead to statistical bias against a start-up. Simply put, there might not be two individuals in two identical (or even similar) positions in a start-up, and the positions themselves might change rapidly in a short period depending on the start-up's development, making it difficult to source accurate information on this.

The IRIS+ catalogue of metrics also contains numerous indicators related to the network within which an organisation operates.[14] While these indicators are very relevant for ensuring the responsible practices of a start-up and the network and community in which they operate, this information may be challenging to source and retrieve (exclusion criterion 1.ii). It is difficult enough for even mature businesses to find out these potentially confidential or sensitive information from their network and partners. It may be even more difficult for a start-up whose new relations may be tainted or jeopardised because they could be perceived as 'snooping' or requiring information their partners feel uncomfortable giving. It may strain newly formed relationships, and approaching partners for this information may be challenging. Furthermore, many start-ups may not even have any partners in the early stages of development, making responding to such questions impossible (exclusion criteria 1.ii. and 1.iii.).

Secondly, the indicators within the IRIS+ catalogue of metrics are sometimes unclear who is responsible for what indicator. While in some instances, there is a social responsibility on a company (e.g., to produce as little waste as possible or to reduce/reuse their waste) (see Appendix 3), they are often not operationalisable for start-ups (i.e., how much waste should they reduce and how should they reuse it). Therefore, several metrics were excluded because it was unclear how a start-up could operationalise these in practice.

Concerning the third exclusion criterion, the IRIS+ catalogue of metrics did not often explicitly discuss socially responsible behaviour. For example, some IRIS+ indicators measured a company's efficiency, such as the metrics relating to units/volume, rather than how to do this in a socially responsible way.

3.1.2. Exclusion criteria applied to RRI projects

When applying exclusion criterion 1.i., to the 12 RRI project reports, some indicators would lead to statistical bias if measured in a start-up. For example, in the MULTI-ACT Master scorecard, the "achievement of milestones indicator" is inapplicable to early-stage start-ups, for it seeks the number and percentage of already achieved research milestones.

Several projects' indicators were often too challenging to source representative information (exclusion criterion 1.ii.). For example, in the MULTI-ACT Master scorecard, the indicator to describe the expected contributions of a start-up in the medical sector to increase overall life expectancy is far too challenging to source realistically in early-stage ventures.

A start-up's size and structure also generally impede the implementability of RRI indicators (exclusion criterion 1.iii.). For example, consider the following indicator from the COMPASS project: 'Scientific content of investment activities is an object of public communication. It is a question that concerns the company's engagement in activities aimed at raising public awareness about the science behind innovations'. It may be challenging for a start-up to invest in economic and labour-intensive work toward public awareness about science and innovation.

The second exclusion criterion precluded indicators that do not provide operational guidance for start-ups or start-up investors. The third exclusion criterion applied was related to indicators that did not focus on commercial applications of RRI (i.e., exclusion criterion 3.ii). However, few indicators were eliminated from this exclusion criterion because of the nature of the projects selected (mostly RRI in commercial

[13] The keywords that guided our search were of two types: The first was related to the issue of the practice of responsible innovation. Among these keywords were: responsible; responsibility; responsible research and innovation (RRI); corporate social responsibility (CSR); sustainability; and impact. The second type of keywords was related to the economic domain and included SMEs; small and medium enterprises; start-ups; enterprise; investment; investor (s); business value; and finance.

[14] For example, some indicators involve gender issues but are applied to business partners as opposed to the members of the organisation: PI1160 and PI6189 measure percentages of business partners (suppliers/distributors) with disabilities; PI4341 and PI6858 measure, respectively, earnings of distributors with disabilities and payments to suppliers with disabilities; and PI7814, PI8470, PI9261, PI9654 concern percentages of business partners (suppliers/distributors) from minorities.

Table 3
List of 24 Indicators[17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40].

Indicator title	Explanation
Data management plan (1)	Start-ups should implement a company-wide data management plan that uses optimal data and privacy protection technologies. Data collection and selection methods should cover the whole gamut of expected beneficiaries and end-users. Data should also be used for positive social impact.
Environmental impact (2)	Start-ups should reduce negative environmental impact and produce positive environmental impact by using sustainable materials, sustainable water management, sustainable green energy, and reducing their carbon footprint. Whenever possible, they should publish a sustainability report on their efforts.
Ethical advisory board (3)	Start-ups should set up an ethical advisory board that can positively impact the behaviour within the organisation. These boards should ensure reflection on responsibility and how management can implement it throughout the organisation. Specific roles and duties of individuals within the organisation must be established.
Monitor positive societal impact (4)	Start-ups should monitor how their company and products positively impact society, reduce risks, and respond to such challenges (e.g., through the precautionary principle). The positive societal impact can be implemented through external auditing, risk assessments, feedback and stakeholder engagement.
Involvement of stakeholders (5)	Relevant stakeholders should be involved effectively in a participatory manner. There should be frequent and efficient stakeholder mapping and engagement exercises, and there is a possibility that stakeholder input can affect decision-making practices (even if this is critical).
Knowledge exchange of stakeholders (6)	There should be an exchange of knowledge between the start-up and stakeholders through education and training about the company and its products. Stakeholders should be given sufficient knowledge and power to voice their concerns.
Empowerment of stakeholders (7)	There should be adequate room for debate, deliberation, and disagreement within the start-up and a setting where this can be voiced fairly and respectfully without penalisation of the individual or group.
Charitable causes (8)	The start-up should optimally contribute to charitable causes or engage in other social activities that give back to society.
Transparent, ethical, and legal data use (9)	The start-up should ensure a level of openness regarding data generated, ensure that it is not exclusionary of any groups and that one's data gathering is in line with the relevant policy and ethical standards while always respecting the legislation in the GDPR. One's data management plan should align with these standards to ensure data protection.
Accessibility of R&D for scientific innovation (10)	The start-up's R&D may provide practical knowledge that others can employ in research, innovation, and the broader scientific community. In this regard, efforts should be made to ensure one's R&D is open access, as long as it does not harm the start-up's business. The start-up should ensure substantial research transparency to the public (and language attuned accordingly).
Internal and external input on socio-ethical impact (11)	A start-up's socio-ethical impact can be facilitated by including both internal and external views in this process. Internal, such as an advisory board that provides input on the socio-ethical impacts of R&D activities. Measures should be taken that the advisory board reflects the broad diversity of views within, and outside, the start-up. While external can come in the form of validation from experts in normative approaches to science (ethics, technical assessments, etc.). If the start-up does not have resources to implement these themselves, they should try to identify ways to allow this (such as through grants, assistance from researchers/universities, free ethical guidelines, and so forth).
Inclusion and plurality of values (12)	Start-ups should receive input from diverse people and groups, considering various views, values, and insights on their products and business.
Training and participation in the R&D process (13)	Participants in the R&D process should be informed about the results of this process. Training/assistance needs to be provided to citizens to participate in the R&D process.
Responsive to socio-ethical impacts (14)	Before the commencement of an R&D process, the start-up should investigate the socio-ethical impacts and create effective feedback loops to be responsive to societal values and risks. The start-up should establish how to make a positive socio-ethical impact while avoiding risks during each stage. It is important to include staff during this process to establish how they can make a positive socio-ethical impact, while avoiding risks, during each stage of this process.
Diversity, decency, and non-discrimination in the workplace (15)	Start-ups should ensure decency, integrity, and fairness in the workplace. Employers should ensure that discrimination based on gender, race, and disability does not occur. Diversity is something that should be valued and implemented in the workplace and staff should be trained in methods of self-reflection and discrimination prevention.
Employee development and work-life balance (16)	Employees should be able to grow and develop while participating in the start-up. They should be allowed to be creative in their roles and have a healthy work-life balance.
Establish core values and provide employee socio-ethical training (17)	Start-ups should implement common core values made explicit and agreed upon by employees (e.g., a Charter, code of conduct, and workshops). Employees should be trained to be aware of socio-ethical issues about the organisation and its product(s).
Respectful of customs, democratic process, and norms (18)	The start-up should respect societal traditions and customs, be sensitive to conventions and norms, and respect public participation in democratic processes. They should ensure their actions and products do not harm public safety.
Anticipate legal requirements and responsibility allocation (19)	The start-up should assess and anticipate legal, regulatory and other requirements related to the product/service. They should assess the presence of partnerships/agreements, establish responsibilities about possible risks and obligations, share information/technology, and implement protection measures for the involved organisations.
Assess social, economic, and environmental impacts of their activities and products (20)	The start-up should assess the potential/actual impacts (social, economic, and environmental) of their activities and products, from design to post-launch. It should consider its positive and negative impacts on innovation, try to prevent harmful impacts of the innovation practices on society and the environment, and re-evaluate these impacts at all life-cycle stages. This can be implemented through external auditing, risk assessments, feedback and stakeholder engagement. i. The business model should integrate profit with environmental and social benefits by identifying the start-up's customer base, distribution mode, needed resources and critical activities, innovation capacities, client value creation, and risks. ii. A start-up should assess a product's life cycle costs (including its short-, medium-, and long-term impact on externalities) and include its principles in a mission statement or code of conduct. iii. The start-up should analyse its impact comprehensively and not restrict it to one criterion, stage or stakeholder (using impact assessment, paying particular attention to environmental and social pillars). iv. They should adopt sustainable development criteria into product and service specifications (choice of material, quality assessment, recycling, and energy management), their choice of suppliers or service providers, and communication activities.
Dealing with the uncertainty of innovation, compliance, and best practices (21)	Start-ups should carry out innovation in a responsible manner, using objectives for assessing performance, such as: i. When uncertain of adverse outcomes, they should decide to invest a minimum amount of their annual share of revenue (this could be 1% or 5% based on the products/services for which this principle applies) in independent

(*continued on next page*)

Table 3 (*continued*)

Indicator title	Explanation
	research and development activities to eliminate, wherever possible, any threats and anticipate the adoption of preventive measures against actual risks. ii. Compliance with standards should follow the stakeholders' expectations, external benchmarks and obligations, the social and environmental impacts, the supply chain, and the law in force. iii. They should periodically review the system of indicators by obtaining appropriate feedback from major stakeholders and follow best practices for assessing performance. Internal and external stakeholders should be involved from the early stages of product development.
Reflection on shared internal experiences and external consultation (22)	The start-up should ensure adequate training is provided for its staff by identifying the skills, knowledge, and experience of staff, as well as their equipment/technology requirements to fulfil their work. Staff should be involved in deciding about their training plans. Time and economic resources should be allocated to reflection, sharing experiences, consulting experts (e.g., on ethics, gender equality, and open access), participation in RRI workshops and training initiatives, and appointment of RRI staff experts.
Fair Distribution of traditionally disadvantaged groups (23)	The start-up should ensure a fair distribution of traditionally disadvantaged groups of highly skilled employees. They should examine the company's demographics to ensure diversity of employees from different backgrounds, genders, and races.
Adaptability to changing societal norms and values (24)	The start-up should be reflexive, open to change when confronted with challenges and shifting norms, and encourage employees to reflect on the start-up's research and innovation. It should reflect on the start-up's economic sustainability, ability to handle the project/product in terms of finances, human resources and materials, and knowledge of risks (turnover, investment capacity, induced financial savings, cash flow).

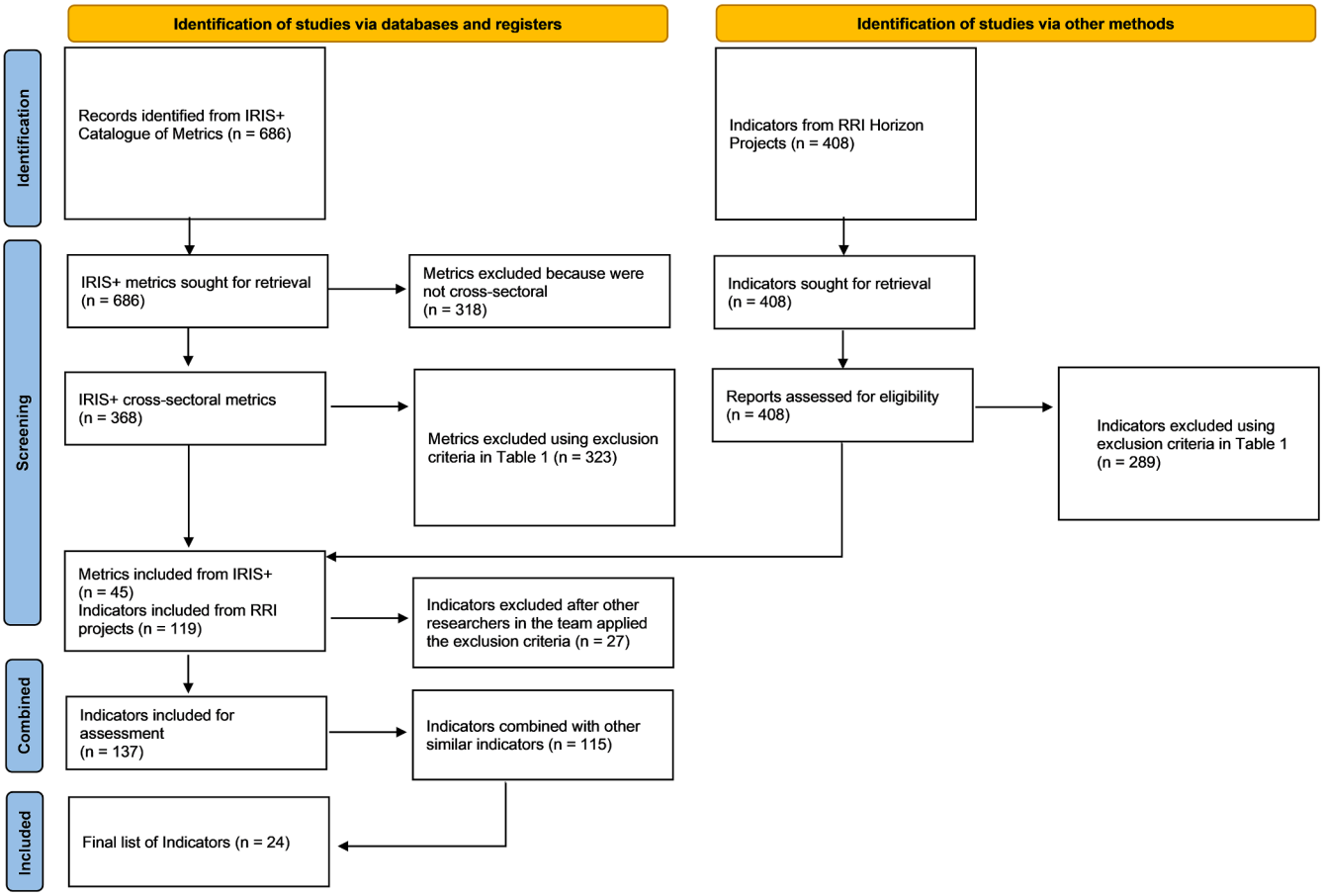

Fig. 1. PRISMA flow diagram (From Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. Doi: 10.1136/bmj.n71. For more information, visit: http://www.prisma-statement.org/).

applications), and most indicators were operationalisable.

3.2. Refining the indicators for start-ups and investors

The exclusion criteria described above were applied by two research teams (one on the IRIS+ catalogue and another on the 12 RRI project reports). This finding resulted in a list of 119 relevant indicators from the 12 RRI projects and 45 relevant indicators from the IRIS+ catalogue of metrics.[15] Subsequently, the two teams swapped tasks and evaluated each other's work for consistency and scientific rigour. Each team reapplied The exclusion criteria by bringing the list down to 137 indicators.

The resulting indicators were then sanitised for overlap by grouping

[15] The entire list of 164 indicators is available upon request

Table 4
RI process requirements and indicators from our results.

RI requirement	Indicator
Anticipation	Ethical Advisory Board (3)
	Monitor Positive Societal Impact (4)
	Establish Core Values and Provide Employee Socio-ethical Training (17)
	Anticipate Legal Requirements and Responsibility Allocation (19)
Inclusion	Involvement of Stakeholders (5)
	Knowledge Exchange of Stakeholders (6) Empowerment of Stakeholders (7)
	Internal and External Input on Socio-ethical Impact (11)
	Inclusion and Plurality of Values (12)
	Training and Participation in the R&D Process (13)
	Respectful of Customs, Democratic Process, and Norms (18)
	Fair Distribution of Traditionally Disadvantaged Groups (23)
Reflexivity	Diversity, decency, and Non-discrimination in the workplace (15)
	Employee Development and Work-life Balance (16)
	Assess the Social, Economic, and Environmental Impacts of their Activities and Products (20)
	Reflection on Shared Internal Experiences and External Consultation (22)
Responsiveness	Data Management Plan (1)
	Environmental Impact (2)
	Charitable Causes (8)
	Transparent, Ethical, and Legal Data Use (9)
	Accessibility of R&D for Scientific Innovation (10)
	Responsive to Socio-ethical Impacts (14)
	Dealing with the Uncertainty of Innovation, Compliance, and Best Practices (21)
	Adaptability to Changing Societal Norms and Values (24)

conceptually relevant indicators into higher levels of aggregation that would be easier to apply and interpret. For example, the first indicator in our list, which will be shown later in Table 3, was initially composed of four separate indicators: "Start-ups should implement a company-wide data management plan (1) that uses optimal technologies for data and privacy protection (2). Data collection and selection methods should cover expected beneficiaries and end-users (3). Data should also be used for positive social impact (4)". This process brought the list of 137 indicators down to 24 indicators (see Fig. 1).

3.3. Testing indicators with start-up and investor stakeholders

The 24 indicators are meant as a way for start-ups and investors in start-ups to engage with and reflect upon social responsibility. After establishing the list of 24 indicators, we consulted many different stakeholders to receive feedback and implemented and tested the indicators in practice (with real start-ups and start-up investors).

The first stakeholder engagement we conducted was a two-hour workshop aimed at identifying the indicators' relevance, usability, and suitability. Participants included angel investors, start-up entrepreneurs, policymakers, and researchers working in socially responsible start-up investment. For the purposes of the workshop, the indicators were reformulated as questions and organised into `worksheets' each focusing on a separate aspect of start-up composition or operational practice; the following seven aspects were identified: data management, the start-up workforce, start-up responsible self-reflection, implementing responsible practice activity reporting, responsible product and organisational reporting, stakeholder involvement, start-up values and ethical training. The seven worksheets were compiled into a single 'workbook'[16] with which our participant engaged and provided feedback on the clarity and helpfulness of its questions, their realism, as well as any other general feedback. The feedback we received is discussed in Section 4.

Secondly, perhaps most importantly, we extensively tested the 24 indicators in six Social Labs (SLs) with 31 stakeholders. SLs (Hassan, 2014; Timmermans, Blok, Braun, Wesselink, & Nielsen, 2020) were introduced by Hassan in 2014 as a method for addressing complex societal challenges on a systemic level, i.e., challenges that cannot be tackled by any single organisation but require, instead, interdisciplinarity sourced from a broad range of stakeholders with diverse expertise and backgrounds (Romero-Frías & Robinson-García, 2017; Kieboom, van Exel, & Sigaloff, 2015; Dessers et al., 2014; Hassan, 2014). The solutions and interventions that SLs experiment with are specific to the social context from which the challenges arise (Lake, Fernando, & Eardley, 2016; Hassan, 2014; Kieboom, 2014; RiCONFIGURE, 2018; Timmermans et al., 2020).

In our case, SLs offer a real-life, albeit controlled, environment within which start-up entrepreneurs and a broad range of stakeholders spanning all helices of the quadruple helix (QH) may experiment with the indicators, collaboratively diagnose their shortcomings, appraise their practical applicability, and evaluate their ability to actuate systemic RI-oriented change and to guide screening for responsibility (e.g., in the context of impact investing). They were chosen over other

[16] This can be seen here: https://drive.google.com/file/d/1nldq5wkqHz1N9idzJ1zB_68k6Js61Zku/view

[17] COMPASS, 2019; GREAT, 2016; ORBIT RRI, 2022; NewhoRRIzon, 2021; Uni/PdR27, 2017.
[18] COMPASS, 2019; GIIN, 2022; KARIM, 2018; MULTI-ACT 2021; ProGReSS, 2016.
[19] COMPASS, 2019; NewhoRRIzon, 2021; ORBIT RRI, 2022; PRISMA, 2019.
[20] COMPASS, 2019; GIIN, 2022; KARIM, 2018; MULTI-ACT 2021; NewhoRRIzon, 2021; ORBIT RRI, 2022; PRISMA, 2019; Uni/PdR27, 2017.
[21] COMPASS, 2019; MULTI-ACT 2021; NewhoRRIzon, 2021; ORBIT RRI, 2022; ROSIE Self-assessment Questionnaire, 2017; Uni/PdR27, 2017.
[22] COMPASS, 2019; GREAT, 2016; NewhoRRIzon, 2021; ORBIT RRI, 2022; PRISMA, 2019; ROSIE Self-assessment Questionnaire, 2017.
[23] NewhoRRIzon, 2021; ROSIE Self-assessment Questionnaire, 2017.
[24] GIIN, 2022.
[25] COMPASS, 2019; GREAT, 2016; NewhoRRIzon, 2021; PRISMA, 2019; Uni/PdR27, 2017.
[26] GREAT, 2016; KARIM, 2018; MULTI-ACT 2021; NewhoRRIzon, 2021; PRISMA, 2019; ROSIE Self-assessment Questionnaire, 2017; Uni/PdR27, 2017.
[27] COMPASS, 2019; KARIM, 2018; MULTI-ACT 2021; NewhoRRIzon, 2021; PRISMA, 2019; ROSIE Self-assessment Questionnaire, 2017.
[28] COMPASS, 2019; MULTI-ACT 2021; NewhoRRIzon, 2021; ProGReSS, 2016; ROSIE Self-assessment Questionnaire, 2017.
[29] COMPASS, 2019; GREAT, 2016; NewhoRRIzon, 2021; ORBIT RRI, 2022; PRISMA, 2019; ROSIE Self-assessment Questionnaire, 2017; Uni/PdR27, 2017.
[30] COMPASS, 2019; GIIN, 2022; KARIM, 2018; MULTI-ACT 2021; NewhoRRIzon, 2021; ORBIT RRI, 2022; PRISMA, 2019; ProGReSS, 2016.
[31] COMPASS, 2019; GIIN, 2022; KARIM, 2018; MULTI-ACT 2021; Newhorrizon, 2021; PRISMA, 2019; ProGReSS, 2016; Responsible Industry Project, 2019.
[32] COMPASS, 2019; GIIN, 2022; NewhoRRIzon, 2021.
[33] COMPASS, 2019; KARIM, 2018; MULTI-ACT 2021; ORBIT RRI, 2022; PRISMA, 2019; Uni/PdR27, 2017.
[34] COMPASS, 2019; GREAT, 2016; PRISMA, 2019; KARIM, 2018; NewhoRRIzon, 2021; ProGReSS, 2016.
[35] COMPASS, 2019; GIIN, 2022; GREAT, 2016; Uni/PdR27, 2017; KARIM, 2018; MULTI-ACT 2021; NewhoRRIzon, 2021.
[36] COMPASS, 2019; GIIN, 2022; KARIM, 2018; MULTI-ACT 2021; NewhoRRIzon, 2021; PRISMA, 2019; ProGReSS, 2016.
[37] COMPASS, 2019; GIIN, 2022; GREAT, 2016; PRISMA, 2019; KARIM, 2018; MULTI-ACT 2021; NewhoRRIzon, 2021; ROSIE Self-assessment Questionnaire, 2017.
[38] COMPASS, 2019; GIIN, 2022; KARIM, 2018; MULTI-ACT 2021; Responsible Industry Project, 2019; ROSIE Self-assessment Questionnaire, 2017.
[39] COMPASS, 2019; GIIN, 2022; KARIM, 2018; MULTI-ACT 2021; NewhoRRIzon, 2021; PRISMA, 2019; ROSIE Self-assessment Questionnaire, 2017.
[40] COMPASS, 2019; GIIN, 2022; GREAT, 2016; KARIM, 2018; MULTI-ACT 2021; Uni/PdR27, 2017.

collaborative problem-solving approaches, such as Participatory Decision-Making, Innovation Labs, and Living labs (Pollastri, Epstein, Heath, & Ablon, 2013) due mainly to their inherent ability to provide space for agile experimentation that dynamically adapts to unforeseen events, emerging properties, new information, and changing environmental conditions; an ability which is particularly suitable for early-stage start-ups that often navigate uncharted waters. Moreover, they have been chosen over other approaches due to their emphasis on inclusivity and mutual learning, which is crucial in our experimentation for the object that is being researched/studied –i.e., the effectiveness of the indicators– and the subjects involved in the research/study –i.e., start-up entrepreneurs and stakeholders from all helices of the QH– are inherently intertwined (Timmermans et al., 2020).

Our testing methodology was put into practice through an empirical and translational 'from-lab-to-market' approach that took place over seven months (From October 2022 to April 2023) and was organised around three distinct innovation ecosystems (with two SLs in each of the three innovation ecosystems, i.e., 6 SLs in total):

1. 3D printing and advanced materials in Italy
2. Bioeconomy (agrifood) in Greece
3. Environmental sustainability in Belgium

Each SL involved a start-up, public/private investors, and stakeholders from all four helices of the QH model, collectively assessing, through practical experimentation, the ability of the indicators to diagnose the level of responsibility in the start-up innovation process and to facilitate its embedment. SL meetings were recorded, and practicals were kept. The practicals were analysed using the documentary method (Ahmed, 2010; McCulloch, 2004; Platt, 1981), which entails systematically collecting and analysing existing documents about the topics subject to investigation. In our work, a deductive manual coding process was adopted (Miles & Huberman, 1984).

4. Results: socially-responsible indicators for start-ups

Based on the extensive analysis of the IRIS+ catalogue of metrics and the 12 RRI project documents, using our exclusion criteria, adopting and clustering the indicators for start-ups and investors, and testing and validating the indicators in a workshop and six SLs this resulted in a final list of 24 indicators (see Table 3).

4.1. Workshop result

During the workshop, we received valuable feedback from the participants on the indicators which allowed us to significantly improve them along several dimensions. Firstly, we removed the ambiguity that some questions exhibited. For example, regarding the workforce worksheet, a participant mentioned that the following question was rather vague: 'What do employees understand by responsibility? How do they employ it?' other participants also reiterated this vagueness.

Secondly, the workbook was often criticised for portraying a binary inclusion agenda (inherited from the IRIS+ catalogue of metrics and the 12 RRI projects) that was not inclusive enough of other genders. We improved this by changing the wording in our indicators to reflect this more inclusive perspective; for instance, we changed the term 'sex' to 'gender'.

Thirdly, many participants indicated that open questions were more appropriate than closed questions for identifying how and where start-ups have attempted to implement responsible practices. We implemented this suggestion to ensure that start-ups and investors can give more nuance to their answers, which also supports our approach of implementing prescriptive indicators.

Fourthly, one participant correctly identified that we correlated, and sometimes conflated, charity and impact. We revised the phrasing of indicator eight to reflect this feedback.

Fifthly, the participants also pointed out that many of the questions in the workbook were overlooked, and how to differentiate them was sometimes unclear. After the workshop, we analysed the indicators to remove as much overlap as possible without harming their content.

Sixthly, the participants stated that many of the questions in the worksheet were phrased as 'How do you do x, y, or z?', which demonstrates a justificatory/defensive reaction from start-ups rather than providing a space where one can learn about the start-up and enable them to improve their responsible practices. After the workshop, we removed any similar cases from the indicator list.

Lastly, we were told that improving the workbook would involve removing as many language idiosyncrasies, abbreviations, and jargon as possible. We implemented all of this feedback into the revised version of the indicators before implementing it in the six SLs.

4.2. SL results

We received feedback about the indicators from the SLs, and the participants only pointed to a few localised changes. The first change was to the *Environmental Impact* (2) indicator to include the following sentence: '*Whenever possible, they should publish a sustainability report on their efforts*'. It responds to a concern raised during the SLs whereby start-ups often lack the knowledge and skills to evaluate their innovations' ethical and social implications. Publishing sustainability reports allows stakeholders, including customers, investors, employees, and the public, to gain insight into an organisation's practices to reduce harm or produce a positive environmental impact. These reports may be used to solicit feedback regarding such practices from a wide range of stakeholders across all helices; this feedback may then be used to evaluate current practices and to inform future sustainability strategies. In addition, sustainability reports may be used to advertise an organisation's commitment to sustainability to attract impact investors and socially aware customers.

The second change extends the *Ethical Advisory Board* indicator (3) to include the following sentence: '*Specific roles and duties of individuals within the organisation must be established*'. It responds to a concern raised during the SLs whereby the lack of clearly delimited roles in start-ups may create ambiguity regarding who is responsible for performing which duties, thus impeding the institutionalisation of responsibility. The allocation of roles to individuals overcomes this ambiguity and leads to more harmonious collaborations within an organisation; it also helps individuals understand how their activities align with organisational goals and imparts them a sense of accountability. This alteration may lead to more efficient RRI institutionalisation.

The third change extends the *Empowerment of Stakeholders* (8) indicator to include the italicised part: 'The start-up should optimally contribute to charitable causes *or engage in other social activities that give back to society*'. It responds to a concern raised during the SLs whereby start-ups often lack the financial resources to exercise socially responsible practices. Engaging in activities that give back to society is a primary form of socially responsible practice (e.g., charitable causes). This activity, however, ordinarily requires that organisations are already profitable, which is not usually the case for early-stage start-ups (i.e., for the kind of start-ups that SRSM focuses on). Therefore, engagement/contribution to other activities that benefit society and incur reduced or no costs is essential for such start-ups to exercise socially responsible practices. In addition to doing societal good, such activities help start-ups to build a favourable reputation and to foster good relationships with stakeholders.

The fourth change extends the indicator for *Internal and External Input on Socio-ethical Impact* (11) to include two additions. Firstly, the inclusion of: '*Measures should be taken that the advisory board reflects the broad diversity of views within, and outside, the start-up*'. The first sentence fosters inclusivity in advisory boards: a prerequisite for ensuring that a wide range of viewpoints is incorporated when receiving input about the socio-ethical impacts of start-ups. It responds to a concern raised during

the SLs whereby start-ups, due mainly to their small size, find it challenging to access diverse viewpoints and ensure inclusivity in their R&D and innovation processes (RRIstart, D2.5). The second addition to this indicator was: '*If the start-up does not have resources to implement these themselves, they should try to identify ways to allow this (such as through grants, assistance from researchers/universities, free ethical guidelines, and so forth)'*. This change aimed to ensure that start-ups can access such input despite their limited resources. This change responds to a concern raised during the SLs whereby the financial costs associated with social and environmental responsibility are often prohibitive for start-ups (RRIstart, D2.5).

The fifth change extends the indicator on *Responsiveness to Socio-ethical Impacts* (14) to include: '*It is important to include staff during this process to establish how they can make a positive socio-ethical impact, while avoiding risks, during each stage of this process*'. It responds to the importance assigned in the SLs to stakeholder interaction and the need to ensure that these interactions will ultimately affect the start-up R&D process (RRIstart, D2.5). Creating feedback loops is essential for staff members to interact with stakeholders and become aware of – and crucially responsive to – societal values, needs and risks. The effectiveness of these feedback loops may be enhanced if staff members are included in this process. Moreover, when staff members are included in the process, they are more likely to feel a sense of ownership and are more motivated to contribute to its success actively.

The sixth change extends the Diversity, Decency, and Non-discrimination indicator *in the workplace* (15) with the italicised part in the following sentence: 'Diversity is something that should be valued and implemented in the workplace *and staff should be trained in methods of self-reflection and discrimination prevention'*. It responds to an affirmation made during the SLs whereby "*by educating start-ups and investors about responsible and impactful entrepreneurship, governments and regulators can help to create a culture of responsible entrepreneurship, where companies are held accountable for their actions and are encouraged to make positive contributions to society*". The indicator change (6) above also responds to the importance of stakeholder interaction highlighted in the SLs and the need to ensure that these interactions will ultimately affect the start-up R&D process. Training staff in self-reflection and anti-discrimination fosters a fair and more productive workspace, raises staff awareness of their own biases and prejudices, enables them to interact with diverse stakeholders more effectively, and sharpens their readiness to respond to societal needs.

The seventh change extends the indicator for Assessing Social, Economic, and Environmental Impacts of Activities and Products (20) with 'This can be implemented through external auditing, risk assessments, feedback and stakeholder engagement'. It emphasises the need for a holistic assessment of innovation activities' actual or potential socio-economic and environmental impacts and their products/services. Akin to the change to indicator P1 (see Section 3.3 above), it also responds to the importance assigned in the SLs to stakeholder interaction and the need to ensure that these interactions will ultimately affect the start-up R&D process.

The eight change extends the indicator on Reflection on Shared Internal Experiences and External Consultation (22) to include 'Staff should be involved in deciding about their training plans'. This change is oriented towards increasing the likelihood of effective and successful training by making staff members stakeholders in deciding upon their training plans. This way, staff members are more motivated and committed towards their training obligations.

5. Discussion

The 24 indicators are a qualitative list of indicators for STEM start-ups to think about their social responsibility and to provide investors with a way to think about how their prospective investment opportunities implement social responsibility in their organisation. The focus on STEM start-up and investors is because of the potentially high-impact that these types of start-ups are, and will have, on society and societal impacts (Ryan et al., 2023). Therefore, the indicators in this paper provide a much-needed first step for providing guidance to STEM start-ups implementing social responsibility (Ryan et al., 2023).

Table 5
EC RRI keys and the indicators from our results.

EC RRI key	Indicator
Public engagement and participation of societal actors in the entire span of the R&I process	Involvement of Stakeholders (5) Empowerment of Stakeholders (7) Internal and External Input on Socio-ethical Impact (11) Inclusion and Plurality of Values (12)
Science literacy and scientific education	Knowledge Exchange of Stakeholders (6) Training and Participation in the R&D Process (13)
Gender equality in research and innovation	Diversity, decency, and Non-discrimination in the workplace (15) Reflection on Shared Internal Experiences and External Consultation (22) Fair Distribution of Traditionally Disadvantaged Groups (23)
Open access to scientific knowledge	Accessibility of R&D for Scientific Innovation (10) Reflection on Shared Internal Experiences and External Consultation (22)
Ethics focusing on research integrity and the ethical acceptability of scientific and technological developments	Environmental Impact (2) Monitor Positive Societal Impact (4) Charitable Causes (8) Transparent, Ethical, and Legal Data Use (9) Responsive to Socio-ethical Impacts (14) Respectful of Customs, Democratic Process, and Norms (18) Assess the Social, Economic, and Environmental Impacts of their Activities and Products (20)
Robust, adaptable and inclusive governance arrangements to pursue or further the other five keys	Data Management Plan (1) Ethical Advisory Board (3) Employee Development and Work-life Balance (16) Establish Core Values and Provide Employee Socio-ethical Training (17) Anticipate Legal Requirements and Responsibility Allocation (19) Dealing with the Uncertainty of Innovation, Compliance, and Best Practices (21) Adaptability to Changing Societal Norms and Values (24)

These indicators were developed from two critical fields of research, SRI and RRI, and bring together insights from both fields of research and complement one another when assessed collectively (e.g., there is a greater balance between economic and social responsibility of the start-up). A significant issue within RRI is that it often focuses on research and innovation and less so on industry applications of social responsibility. Therefore, our indicators build upon the limited literature on *industrial* RRI (e.g., Long and Blok, 2018; Blok & Lemmens, 2015; Nazarko, 2019; and Stahl et al., 2017). Our research also contributes to RRI literature, aligning socially responsible and organisational/business indicators (Kwee, Yaghmaei and Flipse, 2021).

An issue is that there is little research on applying RRI to STEM start-ups and investors. The indicators in this paper are the first step to developing an RRI approach for these two stakeholder groups. In addition, this paper also responds to a criticism often levelled at RRI, namely, that it lacks operationalisation and is too theoretical and vague (Blok, 2018; Pellé and Reber, 2015). For example, there is criticism that the AIRR process requirements lack operationalisation in practice. Our indicators correlate with and clarify how these four process requirements

could be implemented in the context of STEM start-ups (see Table 4).

As can be seen from the table above, there is a clear overlap between our indicators and RRI theory. The indicators substantiate and clarify the four process requirements. This table offers a first step toward clarifying how to apply AIRR and our indicators to start-ups.

The 24 indicators could also be adapted for research projects, which commonly adopt the 6 EC RRI keys (European Commission, 2021). Substantial symmetry exists between our 24 indicators and RRI policy documents. The indicators can be used to translate some of the general and higher-level keys into something more understandable and implementable for STEM start-ups and start-up investors. The indicators provide a way to translate the EC keys into something tangible, namely, STEM start-ups and investors (see Table 5).

In addition to the importance and usability of the 24 indicators for start-ups and investors (Table 3), the list of indicators can also be evaluated in RRI academic contexts (Table 4) and RRI projects (Table 5).

The indicators also respond to criticisms often levelled against SRI for being too focused on the economic impacts of a business' actions (Ryan et al., 2023). While there has been a lot of effort to implement more social responsibility into SRI, there is still often a more considerable emphasis on economic growth and business development (e.g., in positions such as social entrepreneurship (Praszkier, 2011) and the circular economy (Corvellec, Stowell, and Johansson 2022; Kirchherr, Reike, and Hekkert 2017)). While several indicators (e.g., indicators 21–24) give some input on the economic and business aspects, most of the indicators in the results focus more on social responsibility and the impact of start-ups and investing in start-ups on society. Therefore, our indicators emphasise social responsibility, which is often overlooked or given a secondary role in SRI.

In addition, our research methodology has demonstrated the possibility to move along the debate in both RRI and SRI in a manner than synthesises and brings together both approaches within one unifying response to social responsibility in STEM start-ups and investors. Within this paper, we have demonstrated the effectiveness of what Locke and Golden-Biddle (1997) call 'synthesized coherence', which is when approaches 'cite and draw connections between works and investigate streams not typically cited together to suggest the existence of undeveloped research' (p. 1030).

The benefits of taking such approaches is that they bring attention to, identify, and create new lines of inquiry within certain domains that are often underexplored or subjects that are seen as implicit within the field (ibid., p. 1030). And, as we have also shown in this paper, synthesized coherence also allows for the construction of congruent relationships between different research domains (i.e., RRI and SRI) to create a common ground. This allows for greater exchange between those domains rather than ignoring each other's discourse.

The synthesized coherence demonstrated in this paper also allows for the reinterpretation of previous research and research fields to identify possible consensus on the particular topic being discussed (i.e., social responsibility in start-ups and investors). Our research methodology has also demonstrated the effectiveness of making connections between divergent streams of literature that would not otherwise have been possible (ibid., p. 1034). Overall, our approach to synthesise and formulate these two different streams of literature has brought greater coherence to the list of social responsibility indicators than either stream alone could achieve.

6. Conclusion

The 24 qualitative prescriptive indicators are not meant to be used as a checklist where once start-ups meet a certain amount, they are deemed 'socially responsible', which is an inherent risk of green/ethics-washing. They were also not designed to be used as a way to critique, judge, and 'score' start-ups. Instead, the results provide a gross list of indicators to assess a start-up's general social responsibility performance qualitatively. The indicators are meant as a first step for start-ups to start thinking about (and *start doing*) social responsibility, providing them with indicators to self-evaluate their performance and as a way for investors to converse with start-ups about social responsibility. The purpose of the indicators is to allow start-ups and investors to think about social responsibility in an accessible, pragmatic, and open way.

The list of 24 indicators has a dual purpose: firstly, it provides start-ups with a set of indicators to implement for socially responsible behaviour in innovation practices, and secondly, it provides start-up investors with a list of criteria to evaluate the socially responsible nature of the start-ups they want to invest. The main contribution of this paper has been to provide a set of indicators that start-ups and investors can use to help guide them towards socially responsible practice in action.

This paper contributes to the scientific community because current debates on RRI in the industry are sparse and rarely give clear direction for organisations to contextualise and implement RRI principles in practice. In addition, applying RRI to SRI is altogether innovative and adds a much-needed ethically-focused dimension to SRI. Lastly, the scientific literature on investment in start-ups (specifically) in SRI and RRI is minimal, so our paper contributes to this dialogue by initiating a discussion about socially responsible indicators for start-ups and investors.

6.1. Limitations and further research

Considering the exploratory nature of this research, several limitations must be highlighted in our study. One of the main limitations that became evident was the lack of indicators specifically focusing on start-ups. Most indicators we encountered were aimed at mature businesses or not specifically relevant to start-ups. As a result, we had to reformulate many of the basic ideas from the indicators that we found in a relevant and usable way for start-ups.

The indicators may benefit from additional analysis and evaluation. For example, future research could explore a way to assess the relative weight of the various indicators, providing a hierarchy or ranking of indicators. For instance, a DMP and an Ethics committee have the same value. At the same time, a DMP is a tertiary precondition to taking responsibility (i.e., without a DMP, you don't even know whether there is an ethical problem). On the other hand, an ethics committee may be seen as a secondary precondition to take responsibility (i.e., the committee can decide to stop innovation but can also miss it if there are not enough good people on the committee).

In addition, it may be beneficial for research to respond when specific indicators conflict or when there is tension when they are implemented. However, all of this would require an entirely enlarged and altogether different type of research and is beyond the scope of this paper. The indicators in this paper could be ranked, ordered, and developed in a way that could be quantitatively implemented in practice. Additional research could support start-ups by identifying possible contradictions and what to do when there are tensions and conflicts.

Funding

This project was funded under Horizon Grant Agreement: 101005937.

CRediT authorship contribution statement

Mark Ryan: Writing – review & editing, Writing – original draft. **Eugen Popa:** Writing – original draft. **Vincent Blok:** Writing – review & editing, Writing – original draft. **Andrea Declich:** Writing – review & editing, Writing – original draft. **Maresa Berliri:** Writing – review & editing, Writing – original draft. **Alfonso Alfonsi:** Writing – review & editing, Writing – original draft. **Simeon Veloudis:** Writing – review & editing, Writing – original draft. **Natalia Costanzo:** Writing – original draft. **Martina Iannuzzi:** Writing – original draft.

Declaration of competing interest

There are no conflict of interests among any of the co-authors.

Acknowledgements

There are no acknowledgements.

Appendix 1. IRIS+ indicator organisation[41]

Organising categories in the catalogue	Explanation	Example
Metric Identification	These include a code for each metric (e.g., 'OI9891') and a name for each metric (e.g., 'Pesticide use')	PD2584
Definition	Together, these categories explain the content of the metric and how it must be used (e.g., 'Pesticide use refers to insecticides, fungicides, herbicides, disinfectants, and any substance intended for preventing, destroying, attracting, repelling, or controlling any pest…' etc.)	'Describes the area of habitat available to a species within the species' range during the reporting period'
Categories	This category divides the metrics into themes (e.g., 'Agriculture', 'Bio-diversity', 'Climate', 'Infrastructure'). Some metrics fall under a category called 'cross-category', meaning that they are not specific to any one category but more than one. Also, each category has a highlighted sub-category (e.g., 'Employment' has 'Quality jobs'). Finally, two 'higher-order' categories specify whether the metric is focused on positive social impact or positive environmental impact (or both).	Biodiversity
Metrics characteristics	These categories specify various features of the metric (e.g., whether the metric pertains to the company or the product, whether the metric relates to other metrics).	Product Description
SDGs	The Sustainable Development Goals to which the metric pertains	SDG 15: Life on Land SDG Target 15.1. SDG Target 15.2. SDG Target 15.3. SDG Target 15.4. SDG Target 15.5. SDG Target 15.6. SDG Target 15.7.

Appendix 2. IRIS+ indicators for product volume sold

Category of indicators	Number of indicators
Agriculture	32
Biodiversity	5
Biodiversity & Ecosystems	3
Climate	12
Diversity and Inclusion	5
Education	46
Employment	14
Energy	16
Financial services	63
Health	13
Infrastructure	21
Land	19
Pollution	2
Real estate	19
Waste	19
Water	45
SUBTOTAL (specific categories)	318
Cross-category indicators	368
TOTAL	686

Appendix 3. IRIS+ Indicators for waste disposal

Code	Name Indicator	Description Indicator
OI2535	Waste Disposed: Recycled/Reused	Amount of waste disposed of by the organisation through reuse and recycling during the reporting period.
OI4483	Waste Disposed of: Landfill	Amount of waste disposed of by the organisation through landfills during the reporting period.
OI6192	Waste Disposed of: Total	Amount of waste disposed of by the organisation during the reporting period.
OI8357	Waste Disposed of: Incinerated	Amount of waste disposed of by the organisation through incineration during the reporting period.
OI8843	Waste Disposed of: Other	Amount of waste disposed of by the organisation through other means during the reporting period.
OI9847	Waste Disposed of: Composted	Amount of waste disposed of by the organisation through composting during the reporting period.

[41] The codes and definitions found in the IRIS+ catalogue may vary, depending on the version of the catalogue. Our work is based on IRIS+ v5.2 (current at the time of writing); as of June 2022, the current version is 5.3.

References

Ahmed, J. U. (2010). Documentary research method: New dimensions. *Indus Journal of Management & Social Sciences, 4*(1), 1–14.

Alvord, S. H., Brown, L. D., & Letts, C. W. (2004). Social entrepreneurship and societal transformation: An exploratory study. *The Journal of Applied Behavioral Science, 40* (3), 260–282. https://doi.org/10.1177/0021886304266847

Arena, M., Bengo, I., Calderini, M., & Chiodo, V. (2018). Unlocking finance for social tech start-ups: Is there a new opportunity space? *Technological Forecasting and Social Change, 127*, 154–165. hTtps://doi.org/10.1016/j.techfore.2017.05.035.

Asveld, L. (Ed.) (2017). *Responsible innovation 3: A european agenda?* Cham, Switzerland: Springer.

Barrett, J. (2001). The ecological footprint: A metric for corporate sustainability. *Corporate Environmental Strategy, 8*, 316–325.

Bergset, L., & Fichter, K. (2015). Green start-ups – a new typology for sustainable entrepreneurship and innovation research. *Journal of Innovation Management, 3*(3), 118–144. https://doi.org/10.24840/2183-0606_003.003_0009

Blok, V. (2018). Innovation as ethos: Moving beyond csr and practical wisdom in innovation ethics.

Blok, V., & Lemmens, P. (2015). The emerging concept of responsible innovation. Three reasons why it is questionable and calls for a radical transformation of the concept of innovation. In *Responsible innovation, 2* pp. 19–35). Cham: Springer.

Blok, V., Scholten, V., & Long, T. B. (2018). Responsible innovation in industry and the importance of customer orientation: Introduction to the special issue. *International Food and Agribusiness Management Review, 21*(4), 455–462.

Blok, V., Tempels, T., Pietersma, E., & Jansen, L. (2017). Exploring ethical decision making in responsible innovation: The case of innovations for healthy food. In *Responsible innovation, 3* pp. 209–230). Cham: Springer.

Bocken, N. M. P. (2015). Sustainable venture capital – catalyst for sustainable start-up success? *Journal of Cleaner Production, 108*, 647–658. https://doi.org/10.1016/j.jclepro.2015.05.079

Bouri, A. (2011). How standards emerge: The role of investor leadership in realising the potential of IRIS. *Innovations: Technology, Governance, Globalization, 6*(3), 117–131.

Chatterji, A. K., Levine, D. I., & Toffel, M. W. (2009). How well do social ratings actually measure corporate social responsibility? *Journal of Economics & Management Strategy, 18*(1), 125–169.

Cohen, R. (2020). *Impact: Reshaping capitalism to drive real change*. London: Ebury Press.

Cornforth, C. (2014). Understanding and combating mission drift in social enterprises. *Social Enterprise Journal, 10*(1), 3–20.

Corvellec, H., Stowell, A. F., & Johansson, N. (2022). Critiques of the circular economy. *Journal of Industrial Ecology, 26*(2), 421–432. https://doi.org/10.1111/jiec.13187

Cumming, D., Henriques, I., & Sadorsky, P. (2016). 'Cleantech' venture capital around the world. *International Review of Financial Analysis, 44*, 86–97. https://doi.org/10.1016/j.irfa.2016.01.015

Davidsson, P. (2015). Entrepreneurial opportunities and the entrepreneurship nexus: A re-conceptualization. *Journal of Business Venturing, 30*(5), 674–695.

Dessers, E., Vrijhoef, H. J., Annemans, L., Cambré, B., Dhondt, S., Hellings, J., … Van Hootegem, G. (2014). Towards a comprehensive research design for studying integrated care. *International Journal of Care Coordination, 17*(3–4), 105–115.

European Commission, "Proposal for a directive, as regards corporate sustainability reporting (COM/2021/189 final). 0104," 2021, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021PC0189.

Eurosif. (2018). *Eurosif 2018 sri study*. Brussels, Belgium: Eurosif.

Fichter, K., Olteanu, Y., 2019. Green start-up monitor 2018. Borderstep Institut, Bundesverband Deutsche Startups e. V.

Gangi, F., & Varrone, N. (2018). Screening activities by socially responsible funds: A matter of agency? *Journal of Cleaner Production, 197*, 842–855.

Garst, J., Blok, V., Branzei, O., Jansen, L., & Omta, O. S. (2019). Toward a value-sensitive absorptive capacity framework: Navigating intervalue and intravalue conflicts to answer the societal call for health. *Business & Society, 60*(6), 1349–1386.

Hassan, Z. (2014). The social labs revolution: A new approach to solving our most complex challenges. *Stanford Social Innovation Review*. https://doi.org/10.48558/P3XV-KM43.

Henriques, N., & Öberg M. (2016). CSR as a tool for startups to gain external financing: A qualitative study in a Swedish context.

Kieboom, M. (2014). *Lab Matters: Challenging the practice of social innovation laboratories*. Amsterdam: Kennisland. Licensed under CC-BY.

Kieboom, M., van Exel, T., & Sigaloff, C. (2015). *Lab practice: Creating spaces for social change*. Kennisland.

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualising the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling, 127*, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.00

Koenigsmarck, M., & Geissdoerfer, M. (2023). Shifting the focus to measurement: A review of socially responsible investing and sustainability indicators. *Sustainability, 15*, 984.

Koops, B., Oosterlaken, I., Romijn, R., Swierstra, T., & van den Hoven, J. (Eds.). (2015). *Responsible innovation 2: Concepts, approaches and applications*. Springer Cham Heidelberg New York Dordrecht London: Springer International Publishing Switzerland.

Kortenhorst, W., Kortenhorst, J., 2017. Financing the renewables revolution. In: Krosinsky, C., Purdom, S., Hrsg (Eds.), Sustainable investing: Revolutions in theory and practice. Routledge. Taylor & Francis Group.

Kwee, Z., Yaghmaei, E., & Flipse, S. (2021). Responsible research and innovation in practice an exploratory assessment of key performance indicators (KPIs) in a nanomedicine project. *Journal of Responsible Technology*, 5, 100008.

Lake, D., Fernando, H., & Eardley, D. (2016). The social lab classroom: Wrestling with—and learning from—sustainability challenges. *Sustainability: Science, Practice and Policy, 12*(1), 76–87.

Lehoux, P., Silva, H. P., Denis, J. L., Miller, F. A., Pozelli Sabio, R., & Mendell, M. (2021). Moving toward responsible value creation: Business model challenges faced by organizations producing responsible health innovations. *Journal of Product Innovation Management, 38*(5), 548–573.

Locke, K., & Golden-Biddle, K. (1997). Constructing opportunities for contribution: Structuring intertextual coherence and "problematizing" in organizational studies. *Academy of Management Journal, 40*(5), 1023–1062.

Long, T. B., Blok, V., Dorrestijn, S., & Macnaghten, P. (2020). The design and testing of a tool for developing responsible innovation in start-up enterprises. *Journal of Responsible Innovation, 7*(1), 45–75. https://doi.org/10.1080/23299460.2019.1608785

López, M. V., Garcia, A., & Rodriguez, L. (2007). Sustainable development and corporate performance: A study based on the dow jones sustainability index. *Journal of Business Ethics, 75*, 285–300.

Losse, M., & Geissdoerfer, M. (2021). Mapping socially responsible investing: A bibliometric and citation network analysis. *Journal of Cleaner Production,* 296, 126376. doi:hTtps://doi.org/10.1016/j.jclepro.2021.126376.

Maccarrone, P., & Contri, A. M. (2021). Integrating corporate social responsibility into corporate strategy: The role of formal tools. *Sustainability, 13*(22), 1–20.

McCulloch, G. (2004). *Documentary research: In education, history and the social sciences*. Routledge.

Meijer, I., & van de Klippe, W. (2020). Monitoring responsible research and innovation in the European research area: The MoRRI project. In *Assessment of responsible innovation* (pp. 171–195). London: Routledge.

Miles, M. B., & Huberman, A. M. (1984). Drawing valid meaning from qualitative data: Toward a shared craft. *Educational Researcher, 13*(5), 20–30.

MoRRI (2014 –2018). MoRRI project. https://super-morri.eu/morri-2014-2018/.

Nazarko, Ł. (2019). Responsible research and innovation in industry: from ethical acceptability to social desirability. *Corporate social responsibility in the manufacturing and services sectors* (pp. 127–138).

OECD (2022) Social impact investment.

ORBIT RRI (2022). The keys of responsible research and innovation. https://www.orbit-rri.org/resources/keys-of-rri/[accessed 21-01-2022].

Owen, R., Stilgoe, J., Macnaghten, P., Gorman, M., Fisher, E., & Guston, D. H. (2013). A framework for responsible innovation. In R. Owen, J. Bessant, & M. Heintz (Eds.), *Responsible innovation* (pp. 27–51). London, UK: John Wiley & Sons, Ltd.

Owen, R., Stilgoe, J., Macnaghten, P., Gorman, M., Fisher, E., & Guston, D. (2013). A framework for responsible innovation. *Responsible innovation: managing the responsible emergence of science and innovation in society* (pp. 27–50).

Owen, R., von Schomberg, R., & Macnaghten, P. (2021). An unfinished journey? Reflections on a decade of responsible research and innovation. *Journal of Responsible Innovation, 8*(2), 217–233. https://doi.org/10.1080/23299460.2021.1948789

Pellé, S., & Reber, B. (2015). Responsible innovation in the light of moral responsibility. *Journal on Chain and Network Science, 15*(2), 107–117. https://doi.org/10.3920/JCNS2014.x017

Platt, J. (1981). Evidence and proof in documentary research: 1 Some specific problems of documentary research. *The Sociological Review, 29*(1), 31–52.

Pollastri, A. R., Epstein, L. D., Heath, G. H., & Ablon, J. S. (2013). The collaborative problem solving approach: Outcomes across settings. *Harvard Review of Psychiatry, 21*(4), 188–199.

Praszkier, R. (2011). *Social entrepreneurship: Theory and practice*. Cambridge: Cambridge University Press.

Quaranta G., Mastropietro E. (2003), Le condizioni del successo. Linee guida per la creazione d'impresa destinate alla consulenza e alla formazione, Roma: CERFE.

Retolaza, J. L., Ruiz, M., & San-Jose, L. (2009). CSR in business start-ups: An application method for stakeholder engagement. *Corporate Social Responsibility and Environmental Management,16, (6),*, 324–336.

RiCONFIGURE (2018). D1.2 Social labs for quadruple helix collaborations: A manual for designing and implementing social labs in collaborations between industry, academia, policy and citizens. Available at: http://riconfigure.eu/wp-content/uploads/2019/10/D01.2_Social-Lab-Methodology-Manual_v2.0.pdf.

Romero-Frías, E., & Robinson-García, N. (2017). Laboratorios sociales en universidades: Innovación e impacto en medialab UGR (Social Labs in universities: Innovation and impact in medialab UGR). *Comunicar: Revista Científica Iberoamericana de Comunicación y Educación (Scientific Journal of Media Education), 51*(2), 29–38.

Roundy, P., Holzhauer, H., & Dai, Y. (2017). Finance or philanthropy? Exploring the motivations and criteria of impact investors. *Social Responsibility Journal, 13*, 491–512.

Ryan, M., Popa, E. O., Blok, V., Declich, A., Berliri, M., Alfonsi, A., & Veloudis, S. (2023). A model of social responsibility for start-ups: Developing a cross-fertilisation of responsible innovation, the lean start-up approach, and the quadruple helix approach. *Journal of Responsible Innovation, 10*(1), 1–32. https://doi.org/10.1080/23299460.2023.2264615

Ryan, T. K., Mejlgaard, N., & Degn, L. (2021). Organizational patterns of RRI: How organizational properties relate to RRI implementation. *Journal of Responsible Innovation, 8*(2), 320–337.

Scalet, S., & Kelly, T. F. (2010). CSR rating agencies: What is their global impact? *Journal of Business Ethics, 94*, 69–88.

Shank, T.; Manullang, D.; Hill, R. "Doing well while doing good" revisited: A study of socially responsible firms' short-term versus long-term performance. *Managerial Finance* 2005, 31, 33–46.

Shelley-Egan, C., Gjefsen, M. D., & Nydal, R. (2020). Consolidating RRI and open science: Understanding the potential for transformative change. *Life Sciences, Society and Policy*, 16(1), 7.
Searcy, C. (2012). Corporate sustainability performance measurement systems: A review and research agenda. *Journal of Business Ethics, 107*, 239–253.
Spangenberg, J. H. (2016). The corporate human development index CHDI: A tool for corporate social sustainability management and reporting. *Journal of Cleaner Production, 134*, 414–424.
Stahl, B. C., M. Obach, E. Yaghmaei, V. Ikonen, K. Chatfield, and A. Brem. 2017. "The responsible research and innovation (RRI) maturity model: Linking theory and practice." *Sustainability* 9 (6): 1036. https://doi.org/10.3390/su9061036.
Stamm, I., Cruz, A. D., & Cailluet, L. (2019). Entrepreneurial groups. *Historical Social Research/Historische Sozialforschung, 44*(170), 7–41, 4.
Stamm, I., & Gutzeit, M. (2021). Group conditions for entrepreneurial visions: Role confidence, hierarchical congruences, and the imagining of a future in entrepreneurial groups. *Small Business Economics, 59*(3), 1–19.
Timmermans, J., Blok, V., Braun, R., Wesselink, R., & Nielsen, R.Ø. (2020). Social labs as an inclusive methodology to implement and study social change: The case of responsible research and innovation. *Journal of Responsible Innovation, 7*(3), 410–426.
Tracey, P., & Stott, N. (2017). Social innovation: A window on alternative ways of Organising and innovating. *Innovation, 19*(1), 51–60.
van den Hoven, J., Swierstra, T., Koops, B.J., & Romijn (Eds.). (2014). *Responsible innovation 1: Innovative solutions for global issues*. New York London: Springer Dordrecht Heidelberg.
Van De Poel, I., Asveld, L., Flipse, S., Klaassen, P., Kwee, Z., Maia, M., … Yaghmaei, E. (2020). Learning to do responsible innovation in industry: Six lessons. *Journal of Responsible Innovation, 7*(3), 697–707.
Veleva, V., & Ellenbecker, M. (2001). Indicators of sustainable production: Framework and methodology. *Journal of Cleaner Production, 9*, 519–549.
Voinea, C. L., Logger, M., Rauf, F., & Roijakkers, N. (2019). Drivers for sustainable business Models in start-ups: Multiple case studies. *Sustainability, 11*(24), 6884. https://doi.org/10.3390/su11246884
Von Schomberg, R. (2012). Prospects for technology assessment in a framework of responsible research and innovation. *Technikfolgen abschätzen lehren: Bildungspotenziale transdisziplinärer Methoden* (pp. 39–61).
Wevers, H. T., & Voinea, C. L. (2021). Corporate social responsibility as core competence for the business model of social start-ups in The Netherlands. *European Journal of Sustainable Development, 10*(1), 23.
Widyawati, L. (2020). A systematic literature review of socially responsible investment and environmental social governance metrics. *Business Strategy and the Environment, 29*(2), 619–637.
Wöhler, J., & Haase, E. (2022). Exploring investment processes between traditional venture capital investors and sustainable start-ups. *Journal of Cleaner Production, 377*, 134318.

Dr. Mark Ryan is a Digital Ethics Researcher at Wageningen Economic Research, focusing on areas of robotics, AI, and digital developments and responsible innovation. He has published on a wide range of digital ethics topics, such as: smart cities, self-driving vehicles, agricultural data analytics, social robotics, and artificial intelligence.

Dr. Eugen Octav Popa is an argumentation scholar who works in the field of STS (science and technology studies) and RRI (responsible research and innovation). He obtained his PhD in 2016 with a thesis on argumentative interactions in science and published papers on the reasonableness of argumentative interactions, discussion structures for reconstructing scientific debates, friction between stakeholders in innovation projects, technological conflict. He has been involved as a postdoctoral researcher in several Horizon 2020 such as RRI Tools, RiConfigure, and RRIstart. He has also worked with the Dutch Health Council in studying the interaction between scientists and policy makers in cases of public controversy. He currently works as postdoctoral researcher on a project on responsible innovation paths for ultrathin nanomembranes within the Science, Technology and Policy Studies (STEPS) at University of Twente. His work has been published in Informal Logic, Science and Public Policy, Public Understanding of Science, Philosophy and Technology, Life Sciences Society and Policy, and Journal of Pragmatics. He is the winner of the 2016 J. A. Blair prize for the study of argumentation and 2020 prize for the best academic paper (main author together with Vincent Blok and Renate Wesselink) at the ETHAC Conference of the European Triple Helix Association.

Dr. Vincent Blok MBA is Professor in philosophy of technology and responsible innovation at the Philosophy Chair Group, Wageningen University. From 2002 to 2006, Blok held various management functions in the health care sector. In 2006, he became director of the Louis Bolk Institute, an international research institute in the field of organic and sustainable agriculture, nutrition and health care. In 2005 he received his PhD degree in philosophy at Leiden University with a specialization in philosophy of technology.

Andrea Declich is a socio-economist who has worked as a social researcher with several research and training institutes in programs and projects funded by public and private Italian bodies, international institutions including the European Commission, development banks such as the World Bank and the Inter-American Development bank, as well as UN agencies such as FAO, IFAD, UN-Habitat, WHO and OMM.

Maresa Berliri, for over 20 years, she worked in scientific communication, including: the technical and operational organization of several scientific and cultural events (international conferences, seminars, etc.), mostly related to the implementation of European and international projects in both Italy and abroad; the management of Internet sites; technical-scientific secretariat of networks of researchers. To carry out these activities, she has collaborated with various private research institutes in the framework of projects financed by entities such as: European Commission (FP6, FP7, Horizon 2020), WHO, IFAD, UN-Habitat, IOM and several Italian public administrations (such as the Ministry of Foreign Affairs, Ministry of Labor and Social Policies, Lazio Regional Government, Puglia Regional Government, Invalsi) and other public and private bodies, national and international.

Alfonso Alfonsi has participated both in the Istituto di Studi Avanzati di Rocca di Papa and in the Scuola di Sociologia e di Scienze Umane, where he lectured on sociology of religion, history of Italian sociology, leadership theory. In the frame work of the multidisciplinary orientation of the Scuola has also worked on the relationship between social and nature sciences (palaeontology, ethology, biosemiotics). Previous to the establishment of the Scuola, he participated in the organisation of seminars on the epistemology of social sciences and the use of non-standard logics. For about 10 years he was the head of Stesam (Istituto di scienze e tecnologie per lo sviluppo Aldo Moro), a training Institute for post graduate students based in Bari.

Dr Simeon (Simos) Veloudis is an Associate Professor in the Department of Computer Science at CITY College and a Senior Researcher at the South-East European Research Centre (SEERC). He holds a PhD degree in Computer Science from the University of Reading. Simos' research interests lie in the realms of Cloud Computing, Semantic Modelling, Knowledge Representation, Security, and Formal Methods. Over the last decade, his research has attracted significant EC funding through successful participation in FP7 and H2020 projects. He has served as a programme committee member in several international conferences, and as a referee for numerous journals in the areas of Semantic Modelling, Knowledge Representation, Cloud Computing, Security, and Governance and Quality Control.

Natalia Costanzo is an EU project manager at EBAN. Natalia assists the EBAN EU Project Manager in planning and delivering the activities expected from our European funded projects. As such, she coordinates with startups, investors and other actors involved in workshops, events, and other activities, she participates to consortium meetings and planning of tasks with project partners, she helps with project reporting and with the preparation of new EU Project tenders and proposals. She is graduating from her MSc in Management at Bocconi University where she focused on courses about Entrepreneurship and Sustainability. She gained valuable insights in the startup and sustainability fields also as a member of Cuora Consulting, first as a consultant and then as Head of Project Management. Cuora is a student-run association providing consulting services specifically to sustainable entities or projects.

Martina Iannuzzi is an EU project manager at EBAN. As the EU Projects Manager, Martina works together with the team on EU-funded projects and other pan-European projects and initiatives. Before joining EBAN, she worked in Equity Research for a Milan-based financial advisory boutique – where she scouted strategic buyers and targets for M&A transactions across Italy and abroad –, and as Research Assistant for the Department of Finance of Università Bocconi – where she collaborated on a research about Circular Economy and Finance. Through these roles she got exposure to key trends and topics related to green investing, sustainable development and SMEs growth. Martina holds an M. Sc in International Management from Università Bocconi and had the chance to live and study in Asia for more than two years overall, during which she often engaged with the dynamic entrepreneurial cummunity of Shanghai and Seoul.