How to Support Startups in Responsible Innovation Processes: A Tool Analysis

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Abstract. Innovation plays a vital role in economic growth and addressing societal challenges such as climate change, poverty, and ageing populations. However, the impacts of innovation are not always predictable, and negative outcomes can emerge unexpectedly. Anticipating the long-term effects of innovation is becoming increasingly important as technology and innovation continue to advance at a rapid pace. Responsible Innovation (RI) is an approach that aims to govern research and innovation by involving stakeholders early on to improve anticipation of consequences and make innovation ethically acceptable, environmentally sustainable, and socially desirable. Small enterprises, particularly start-ups, face significant challenges in implementing sustainability and responsibility in their innovation processes due to limited resources. This study aims to explore existing tools for operationalizing RI in a business context and assess their applicability to start-ups. The findings reveal that while there are numerous ongoing projects and tools for RI in a business context, there is a lack of tools specifically designed for start-ups. By identifying key concepts and characteristics of tools for RI implementation in start-ups, the paper contributes to the field of RI by laying the groundwork for the development of an RI tool tailored to the needs of start-ups. The study provides recommendations for improving existing RI tools, including the development of modular and user-adaptive tools. This research expands the knowledge base on RI, offers a theoretical foundation for further research, and paves the way for the development of the COMPASS self-check tool for RI implementation in start-ups.

Keywords: Responsible Innovation; Tool; Start-Up; RI implementation; COMPASS self-check tool

1. Introduction

Innovations have a tremendous impact on economic growth (Broughel & Thierer, 2019) and are needed to overcome great societal challenges like climate change, increasing energy needs, poverty, or ageing society (von Schomberg, 2013). Still, the impacts of innovation cannot always be predicted correctly and often innovation comes with unforeseeable challenges and negative outputs (Long et al., 2020). Long-term effects of innovation often only arise at a late stage and cannot be foreseen at the beginning (Lubberink et al., 2017b). The positive and negative impact of innovation increases with the constantly rising extent of technology and innovation (Stilgoe et al., 2013) and with a frequently faster pace of innovation pace. Hence, impact anticipation in innovation processes becomes more and more important (Long et al., 2020).

The concept of responsible innovation (RI) is defined as an approach to govern research and innovation, by including stakeholders in early development stages, to improve anticipation of consequences (Lubberink et al., 2017b). RI pursues the goal to make innovation ethically acceptable, environmentally sustainable, and socially desirable (Stilgoe et al., 2013). As companies nowadays face the challenges to design their processes and products more sustainably, RI can per se be a vehicle to pave the way to pursue their goals, while also having positive impacts on sustainable development goals (Lubberink et al., 2017b).

Still, framing new or existing companies towards more sustainability is a huge challenge, as it involves several institutions and stakeholders. Long et al. (2020) state that the need for a conceptualized approach to improve innovation processes and integrate sustainability and responsibility in innovations and processes arises. Especially for small enterprises like start-ups a guiding approach is crucial since they lack resources for controlling instruments like corporate social responsibility or corporate sustainability (Gurzawska, 2021).

To address this challenge, the aim of this study is to explore which tools for operationalizing RI in a business context exist. In this context, it needs to be analyzed which tools are suitable for startups and derived which characteristics are necessary for a tool to be applicable for a startup. Therefore, three central research questions arise:

RQ1: Which tools exist to operationalize RI in a business context?

RQ2: Which RI tools are applicable in a start-up context?

RQ3: How do existing RI tools need to evolve to improve their applicability in the context of start-ups?

By answering these research questions, the paper contributes to the body of knowledge on the RI field, by exploring existing tools for the practical implementation of RI in startups. Based on the findings, key concepts and main characteristics of the tools and their application factors are identified, which provides the fundament for further developing an RI tool for startups.

2. Methodological approach

The basis of this paper builds on a systematic literature review (SLR) to identify existing tools for the application of RI in a business context, with the special focus on start-ups. The SLR is necessary to get a better understanding of existing tools and to identify the research gaps (Booth et al., 2016). Considering Kitchenham and Charters (2007) approach, a research strategy and review protocol for the selection of the most relevant literature is created. Afterwards, the existing literature and models are reviewed and selected for further evaluation.

Following the CIMO (context-intervention-mechanism-outcomes) method by Booth et al. (2016) a search string is derived, dividing the keywords into four categories, thereby supporting the structure of the search string regarding the addressed research questions. This results in the following search string:

"(Responsible Innovation OR RI OR RRI OR Responsible Research and Innovation OR ((responsible OR responsibility OR sustainable OR sustainability) AND (Research & Innovation OR Research and Innovation OR innovation OR invention OR design OR founding OR foundation OR product development)) AND (application OR framework OR Tool OR operationalization OR operationalization OR implementation OR implementing OR instrument OR model OR supporting structure OR determinants OR impact OR assessment) AND (business OR industry OR work environment OR corporate context OR enterprises OR company context OR start-up OR entrepreneurial context OR entrepreneurship)"

The search process begins in online libraries such as EBSCO S1, KIT Library, Scopus, Web of Science, and IEEE Xplore. Two cycles of selection, backwards and forward citation, and an internet search are conducted, leading to 153 sources. Journal rankings and the CIMO method are used to further narrow down the selection to 21 sources that focus on the four determinants of RI. In total, 11 tools are analysed, with an additional four found in the RRI Toolkit. The combined search results in 15 different tools analysed.

For the evaluation, the following criteria for a comparable description of the different tools are used: reference in journal; part of RRI Toolkit; type (guideline, questionnaire, checkbox, evaluation, workshop and template); inclusion of EU guidelines; holistic nature and start-up focus. In the case of multiple publications concerning one tool, the different information is compared and synthesized. The evaluation of the tools is conducted in two stages. In the first stage, the tools are evaluated regarding the inclusion of the definition of RI, the four RI determinants by Owen et al. (2013), the six RI principles by the European Union (2020), and the applicability of the tool. The second stage is based on evaluation criteria, derived from the literature. The evaluation criteria describe tool requirements for the implementation of RI, from an academic perspective.

3. Results

The SLR in combination with the RRI Toolkit reveals 15 different tools as an input for the tool evaluation, shown in Figure 3 with their respective origin. In the following, the respective tools will be described in detail.

3.1 Tools referenced only in RRI Toolkit

The Corporate Responsibility Tool provides recommendations for the use of a set of given standards, global initiatives, and principles. Depending on the main goal of a company implementing RI, they recommend standards, guidelines, and norms for environmental protection, human rights, human health, sustainability, or business ethics.

The Ethical Operating System toolkit (EOS) is a tool with the goal to identify, anticipate and visualize future risks in the innovation and product development process at an early stage (Omidyar Network et al., 2018). Therefore, eight risk zones are identified, to address areas where unexpected risks are likely to occur.

The PAS (Publicly Available Specification) Responsible Innovation Guide provides two application frameworks to take responsibility more tangible, one focusing more on responsibility at a company level; the other targeting the innovation or product level (The British Standards Institution, 2021).

The RRI Toolkit project team itself developed the *self-reflection tool*, which targets the self-reflection of innovators and entrepreneurs on their research and innovation processes. It supports the self-reflection of RI practices within an innovation process by asking questions with a focus on these guidelines (RRI Tools, 2021).

3.2 Tools referenced in literature and RRI Toolkit

The PRISMA project offers an entire website including a roadmap to RI and KPIs for companies, as well as an own toolkit with different approaches. The toolkit offers tools for various application fields and refers to other tools from the RRI Toolkit (PRISMA Project, 2019).

The Responsibility Navigator Guidebook offers two frameworks: The Responsibility Navigator itself and the Co-construction method. It shall support the identification, development, and implementation of measures to institutionalize responsibility in the processes and ambition of a company (Res Agora Project, 2021).

The COMPASS website is structured in a similar way to the Responsibility Navigator. It provides companies with two tools, the self-check tool, and the co-creation method kit. The self-check tool offers companies the possibility for self-evaluation on the implementation of RI principles (Institute for Managing Sustainability, 2020). The Co-Creation toolkit supplements the self-check tool with a workshop guideline and provides a roadmap to evaluate the key challenges (Institute for Managing Sustainability, 2016).

The KARIM framework divides RI into three axes. It gives companies an overview of the advantages of the implementation of RI into the development process and helps to translate the sustainable development objective into an innovation project. Therefore, an RI analysis tool is provided (KARIM Interreg IVB, 2015).

3.3 Tools referenced only in literature

The RMoI tool provides a conceptual model to operationalize the RI principles with the help of the four determinants. It focuses on the question of how RI concepts can be transferred from an academic context to praxis within three steps (Long et al., 2020).

ORBIT provides two frameworks: The ORBIT self-assessment tool and the AREA 4P framework. The self-assessment tool is an online questionnaire with registration and a personalized account. The key areas are a mix of the four determinants by Owen et al. (2013) and the EU policy agendas (ORBIT RRI, 2021).

The AREA 4P Framework is a matrix, which provides guiding questions. The questions help to identify how responsible innovation is. One axis of the matrix is based on the four determinants by Owen et al. (2013) and the other on the four P's (process, product, purpose, and people) (ORBIT RRI, 2021).

The Societal Readiness Thinking tool emerged from the European Union Horizon project. It combines a conventional stage-gate approach with a questionnaire matrix on the fulfilment of RI. The stage gate approach divides the innovation process into four parts. The matrix is based on the four determinants according to Long et. al and the EU policy agenda (Jong et al., 2020; Nielsen et al., 2018).

The stage gate approach defines responsibility criteria for different product gates, to evaluate if an innovation passes a gate or not. The stage gate approach for RI builds upon the established stage gate approach for product development (Owen et al., 2013).

The Requirement tool for Stakeholder Engagement defines requirements for RI implementation to get commonly valid guidelines for RI. It focuses on the creation of common sense in RI to create a better engagement of stakeholders (Wilford, 2019).

The GRACE Reflection tool helps companies to reflect on the implementation of RI within their organization. It provides a blueprint sheet for the evaluation of an existing RI initiative within a company and evaluates the RI initiative about its effectiveness and impact on the six EU policy agendas (GRACE Project, 2021).

4. Discussion

To evaluate the existing tools, criteria from the literature are derived and applied in two stages. The criteria of the first evaluation stage include (1) inclusion of the most common RI concepts (definition of RI; four RI determinants by Owen et al. (2013); six RI principles by European Union (2020)) as well as the (2) origin and applicability of the tool. The second evaluation stage reflects upon (1) requirements and qualifiers for RI tools, derived from literature, and (2) suitability for innovation processes within impact start-ups.

For the first-stage evaluation selection sheets are used, including a checklist with several inclusion and exclusion criteria for the previously explained tools. It builds upon the definition of RI and on the existing policy guidelines (four determinants of RI, six EU principles). One criterion is the origin and appearance of the tool. It contains the information if the RRI Homepage and/or literature refers to the tool. Another criterion evaluates the nature and application of the tool. It provides the information if it is a guideline, questionnaire, checkbox, KPI list, feedback system, workshop format, or application blueprint. Additionally, the selection sheet includes the evaluation of the holistic nature of the tools. It includes information if all relevant aspects of the RI definition are included. Last, it investigates the integration of the six EU principles in the tool.

For the second stage of evaluation, further requirements are applied. Based on the vibrant and ongoing discussion on RI, the requirements for literature on RI tools are diverse. One requirement is the applicability in different industry contexts. Yet, there is consent that different company forms request different criteria for a tool (Groves, 2017), leading to the requirements for a flexible and non-compulsory approach to serve different fields of research and fulfil the requirements of different industries (RRI Tools Consortium, 2021). Hence, the easy adjustability to different company and industry environments helps to increase the scalability of such a tool. In addition, a tool must consider start-up and small company-specific requirements.

To successfully implement Responsible Innovation (RI) in a business context, stakeholders should be involved throughout the innovation process (Lubberink et al., 2017a). Integrating the pillars of RI early on in the process can identify critical issues, making them easier and less costly to address (Egeland et al., 2019). An effective RI tool should focus on positive aspects and provide benefits to entrepreneurs, rather than solely mitigating risks and punishing negative impacts (Gurzawska, 2021). It should also offer guidance, measuring key performance indicators and incentives for RI implementation. To ensure applicability and comparability in a company context, a tool should provide qualifiers that define "good quality RI" (Fraaije et al., 2020). Additionally, the tool should appropriately address conflicting aspects of RI, such as balancing economic impact and financial targets or freedom of science and regulation and governance (Gurzawska et al., 2021; Owen et al., 2021).

4.1 Evaluation stage one

Some of the previously described tools do not pass the selection process of the selection sheets and will not be included in the further evaluation process. The Corporate Responsibility Tools by Iatridis (2021) is rather a summary and not a tool in the sense of interaction with the user, also not providing any concrete application template or evaluation of a company or product. Similarly, the stage gate approach does not provide any template or application blueprint. It rather describes the well-known stage gate approach from product development. In addition, it does not give any guidelines on the integration of the EU principles (Owen et al., 2013). The focus of the requirement tool by Wilford (2019) is on the creation of requirements and criteria for an RI guideline. It does not provide a blueprint for the application of RI in a company context. The GRACE reflection tool by the GRACE Project (2021) does not display any holistic evaluation or integration of RI in a company. It is a complementary template to evaluate existing RI initiatives regarding their impact.

4.2 Evaluation stage two

The evaluation stage of Responsible Innovation (RI) includes several tools such as EOS toolkit, PRISMA, Responsibility Navigator, COMPASS self-check tool, PAS Responsible Innovation Guide, Self-Reflection tool, KARIM, RMoI tool, Orbit self-assessment tool/Orbit AREA 4P framework, and the Societal thinking readiness tool.

The EOS toolkit is flexible and applicable to different industries, with a focus on tech companies (Omidyar Network et al., 2018). However, it does not provide any evaluation or scoring nor covers all aspects of RI. It excludes the environmental component of RI and does not consider the EU principles of gender equality and open access. The tool only focuses on the innovation itself while the holistic company view is not included.

The PAS Responsible Innovation Guide (The British Standards Institution, 2021) is general and not industry-specific. It differentiates between the company and product levels and considers the different stages of the innovation process. However, it is vague, open, and lacks clear RI qualifiers. It gives limited guidance and is not interactive.

The Self-Reflection tool is a questionnaire template that partially supports a self-evaluation (RRI Tools, 2021). It strongly emphasizes the "to-do list" to achieve a certain responsibility goal, but does not define any qualifiers to evaluate innovation, the innovation process, or the company. It is not compatible with the start-up process.

The PRISMA approach provides a guideline with recommendations, a list of KPIs, and a template for a company roadmap (Lehoux et al., 2020; van de Poel et al., 2017). It is closely related to the EU principles and focuses on society and ethics. However, it does not offer any evaluation of a company or innovation. It is a holistic approach when it comes to the innovation process and is applicable in various different industries, but the target industry of the roadmap is definitely technology innovation. PRISMA definitely focuses on the positive impacts of innovation and rather gives hints on how to improve impact instead of pointing out things to avoid. The guidance of PRISMA is limited and especially in a start-up environment, it may not be very useful.

The Responsibility Navigator is available on the RRI homepage and includes a guideline, questionnaire, and workshop format (Res Agora Project, 2021). It has a holistic approach towards all aspects of RI and all EU principles. It is not product-centred, industry-specific, or aimed at a certain innovation.

The COMPASS framework is available in the literature and on the RI homepage (Lehoux et al., 2020). It includes a self-check tool, evaluation, and a workshop format. It has a holistic approach towards all EU principles, with a focus on ethics and society. It includes the whole innovation process, starting from the product life cycle stages to the commercialization phase.

The KARIM Network provides a template for a checkbox to execute a self-assessment and determine fields to improve (KARIM Interreg IVB, 2015). It is a holistic approach towards environmental, social, and ethical aspects but does not cover all EU principles. It is not industry-specific and focuses on innovation as a physical product.

The RMoI tool is a guideline and application format that gives suggestions but not qualifiers or clear KPIs (Long et al., 2020). It is designed specifically for start-ups, but it is vague and abstract, making it difficult to apply. The ORBIT toolset provides a holistic concept with an RI guideline, self-assessment questionnaire, evaluation, and an evaluation matrix with the AREA 4P framework. It is not industry-specific and can be applied to different company contexts.

ORBIT is a toolset that follows academic knowledge on responsible innovation (ORBIT RRI, 2021). It provides a holistic concept with an RI guideline, a self-assessment questionnaire with evaluation and a graphical representation, and an evaluation matrix with the AREA 4P framework. The toolset is not industry-specific and can be used in various contexts. It is grounded on EU principles and the four determinants, covering all aspects of RI, but it does not focus on recognizing the positive impacts of RI. The self-assessment tool includes qualifiers, and the tool is easy to understand and has a nice graphical representation, making it applicable in a start-up context. However, it is quite comprehensive and time-consuming, which may conflict with limited start-up capacity.

The societal thinking readiness tool is from an EU-funded RI project called New Horizon (Nielsen et al., 2018). It provides a guideline and questionnaire, but it does not include an evaluation or application template. The stage gate approach mainly focuses on the product innovation process and considers the entire innovation cycle, but it does not include the company view. The tool is based on EU principles and the RI determinants, making it a flexible tool applicable to all industries and compatible with the start-up cycle. However, it does not cover environmental sustainability aspects.

4.3 Selection of a tool for further analysis

Upon a detailed evaluation of various RI tools, several observations can be made. It is notable that none of the tools are industry-specific, making them universally applicable across different industries. Most of the tools are designed to consider all aspects of RI and align with the EU principles. However, some tools, such as the Ethical Operating System toolkit, focus only on a specific aspect of RI, failing to meet this requirement. While most of the tools aim to highlight the positive impacts of RI, some underrepresented the full range of benefits that can be derived from RI, including social, environmental, and business benefits. Furthermore, most of the tools focus on the research and development phase and neglect the "product-in-the-market-phase" and its impact on the company.

Regarding the features of an ideal RI tool, most of the tools fail to provide an applicable template, interactivity, and scoring system to enable comparison with other companies. Only the COMPASS self-check tool and the ORBIT self-assessment tool meet these requirements. In terms of clear qualifiers, these two tools also provide clear guidance on what qualifies a product, process, or company for RI. However, the RI tools underrepresent the issue of addressing conflicting aspects of RI in a business context. While some tools such as COMPASS and KARIM Network partially address such conflicts, many open issues remain unaddressed (Gurzawska, 2021).

Considering the applicability of these tools for start-ups, it is observed that all of the tools can be applied. However, the time-efficiency, cost-efficiency, and ease of application required for start-ups may conflict with other requirements of an RI tool such as holism and integrative approaches, which can increase the complexity and application time. While some tools partially meet the requirements for adaptability to different development stages and dynamic processes, the COMPASS self-check tool appears to be the most suitable for start-ups due to its scoring model, measurability, and comparability with other companies.

4.4 Evaluation of the COMPASS self-check tool

Based on the findings, the COMPASS self-check tool represents a good starting point for the further development of a tool for RI in start-ups. By including most of the evaluation requirements and approaches like the scoring model via percentages or the trial to gamify RI, it is suitable for practical application. Additionally, start-ups should be able to use it within limited resources. Yet, the tool still faces potential improvement aspects, which are summarized as recommendations for further development of the tool.

To ensure the value of RI tools, COMPASS should focus on highlighting the positive aspects of implementation, rather than punishment (Gurzawska, 2021). An interlinkage of actions and effects can aid in decision-making and the allocation of resources. KPIs can help standardize processes and make the tool a decision guide (Dreyer et al., 2017). The tool should be integrated into company regulations and evaluated and adjusted before becoming a standard. EU-funded projects should be bundled to create one commonly accepted tool.

Field experiments with companies are needed to evaluate the value of the RI tool in practice. Financial and business modelling aspects should also be integrated, along with KPIs to measure and compare impacts. This aligns with the recommendation to link RI measures and effects with KPIs (Cangioni et al., 2016).

Additionally, potential target conflicts within the implementation of RI should be integrated (Owen et al., 2013). While not only providing transparency about potential conflicts but also supporting guidance on how to deal with such conflicts it complements the tool and makes it more tangible. The section shall help a company to strengthen its system of values and to define its own guideline on how to prioritize among target conflicts (Dreyer et al., 2017). To support this process, the respected effects of different decisions must be linked to the RI measures.

Increasing the flexibility and adaptability of the tool is another recommendation for improvement. A multimodal toolkit is required that supplies the users according to their needs. Yet, the basic components and requirements should remain the same among one impact category to ensure comparability. However, the contents change over time of the innovation cycle or depending on the impact category (Parker, 2006). The multimodal toolkit should adjust to the different lifecycle stages of a company, aligning with requirements from the literature to adapt to dynamic and frequently changing processes in start-ups (Elia et al., 2020).

5. Conclusion, Limitations, and Further Research

Summarizing the findings of the research it becomes obvious that there are already many ongoing or completed projects in the research field of RI in a business context. Yet, there is still a lot of potential in the operationalization of RI in start-ups, especially regarding integrated approaches of academic concepts and requirements from practical application.

Considering the first research question, a variety of tools addressing the topic, originating from literature and different EU projects, were identified. The tools were found through the SLR and the RRI Toolkit website. Yet, none of the tools is commonly used or spread in a business context, even though the concept of RI receives growing awareness within the last few years.

Regarding the second research question, asking for tools applicable to start-ups, no tools were identified.

By evaluating existing RI tools, success factors, as well as deficiencies, were derived, which were transformed into improvement suggestions, addressing the third research question. By designing a modular tool with further sections but also user-based adaptations, existing tools can be improved to enhance their applicability in the context of startups.

The study contributes to the current state of research, giving an overview of all existing tools for RI operationalization in a business context. By evaluating the existing tools based on predefined criteria, this study

enables a valid theoretical base for further research in the operationalization of RI. Further, it builds a foundation for the further development of the COMPASS self-check tool focusing on RI implementation in startups.

Hence, in further research, stakeholders of several areas in the startup field should be interviewed to support the further devolvement of the tool. Additionally, field experiments in practice should be conducted, to gain more insights on the effects of the application of such a tool. Also, by conducting a survey that focuses on the evaluation of the requirements of an RI tool, a wider population can be integrated, thereby increasing the validity but also awareness of such a tool.

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