Kaunas University of Technology

School of Economics and Business

Strategic Implementation of Responsible Innovation in SMEs: The Case of Biotechnology Firms in Germany

Master's Final Degree Project

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Summary

The awareness for major global challenges such as climate change is rising globally among industry and consumers. There is a large consensus that innovative solutions are needed to solve these challenges. Unfortunately, several negative examples in the past have shown that innovations can have unintended negative consequences. To develop innovative solutions that are ethically acceptable, socially desirable and sustainable as well as do not create new problems, the concept of Responsible Innovation (RI) can be applied. However, the concept is complex, still relatively new and has been predominantly applied in academic research, although many innovations are developed in industry. This makes RI difficult to adapt, especially for SMEs, the most common form of businesses in Europe, which often have limited resources. But first empirical findings have shown that RI implementation in a firm can be associated with competitive benefits.

Therefore, the **research aim** is to ground a conceptual framework for strategic implementation of RI in biotechnology SMEs.

To achieve the research aim, the following **research objectives** were set:

1. To analyse the situation of RI implementation in academia and business context with special focus on SMEs.
2. To perform a theoretical analysis of strategic implementation in SMEs with regard to RI by identifying its main drivers and barriers.
3. To develop a conceptual framework for strategic implementation of RI in SMEs based on the conceptualized relationships between the purpose, innovation process and outcome level.
4. To substantiate a methodology for analysing the strategic implementation of RI in the biotechnology sector in Germany.
5. To empirically validate the strategic RI implementation framework in SMEs and extract dominant profiles of strategic RI implementation in biotechnology firms.

The **research methods** applied in this work include the analysis of scientific literature to identify and ground the elements of the conceptual framework for strategic implementation of RI in SMEs. To validate the framework in a qualitative study, a multiple case study analysis was conducted. Biotechnology SMEs in Germany were selected as the research context. The data was collected through desk research on secondary data and semi structured interviews. A qualitative content analysis was performed to extract the relevant information to validate the conceptual framework.

The **key theoretical findings** include the characteristics of strategic implementation, key drivers and barriers of RI implementation in SMEs and key elements of RI implementation in a firm. On this basis, a conceptual framework for strategic implementation of RI in SMEs was developed, which emphasises a code of conduct as a central element for formalising RI.

The **key empirical findings** suggest accepting the proposed conceptual framework and its elements in the given context. Two additional key elements of strategic implementation of RI were identified, namely the manifestation of benefits/competitive advantages to be obtained by RI implementation and the assessment of responsibility along the value chain.

Furthermore, two dominant profiles were identified that could be related to strategic implementation of RI, namely the personal motivation and values of the founder and the involvement of employees in strategic processes and decisions.

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Santrauka

Pramonės atstovai ir vartotojai vis labiau atsižvelgia į pagrindinius pasaulinius iššūkius, tokius kaip klimato kaita. Visuotinai sutariama, kad šiems iššūkiams spręsti reikalingi novatoriški sprendimai. Deja, keli neigiami praeities pavyzdžiai parodė, kad inovacijos taip pat gali sukelti nepageidaujamų negatyvių pasekmių. Norint kurti inovacinius sprendimus, kurie būtų etiškai priimtini, socialiai pageidautini ir tvarūs, taip pat nesukeltų nepageidaujamų padarinių, galima taikyti atsakingųjų inovacijų (AI, angl. Responsible Innovation, RI) koncepciją. Tačiau ši koncepcija yra kompleksiška, vis dar vystoma ir plėtojama daugiausia akademiniuose tyrimuose, nors daug inovacijų kuriama ir pramonėje. Dėl to AI sunku praktiškai pritaikyti, ypač SVV įmonėms, kurios Europoje yra labiausiai paplitusi verslo forma ir kurių ištekliai dažnai yra riboti. Tačiau jau egzistuoja empirinių tyrimų, pagrindžiančių AI diegimą įmonėje su konkurencine nauda.

Todėl šio darbo tyrimo tikslas - pagrįsti konceptualų strateginį AI diegimo modelį biotechnologijų SVV.

Tyrimo tikslui pasiekti buvo iškelti šie tyrimo uždaviniai:

1. Išanalizuoti AI diegimo situaciją akademiniame ir verslo kontekstuose specifiškai fokusuojantis į SVV.
2. Atlikti teorinę SVV strateginio diegimo AI atžvilgiu analizę identifikuojant esminius motyvuojančius veiksnius ir barjerius.
3. Sukurti konceptualų strateginį AI diegimo SVV modelį grindžiant konceptualiais ryšiais tarp tikslo, inovacijų proceso ir rezultatų.
4. Pagrįsti strateginio AI diegimo modelio Vokietijos biotechnologijų sektoriuje metodologiją.
5. Empiriškai patvirtinti strateginį AI diegimo modelį SVV įmonėse ir išskirti dominuojančius strateginio AI diegimo profilius biotechnologijų įmonėse.

Šiame darbe taikyti tyrimo metodai apima mokslinės literatūros analizę, siekiant nustatyti ir pagrįsti strateginio AI diegimo SVV konceptualaus modelio elementus. Siekiant patvirtinti konceptualų modelį kokybiniame tyrime, buvo atlikta kelių atvejų analizė. Buvo pasirinktos biotechnologijų SVV įmonės Vokietijoje. Duomenys buvo renkami atliekant antrinių duomenų analizę ir pusiau struktūruotus interviu. Surinktiems duomenims analizuoti bei validuoti konceptualų modelį pasitelkta kokybinė turinio analizė.
Pagrindinės teorinės išvados apima strateginio diegimo ypatumus, pagrindinius AI diegimo SVV įmonėse motyvuojančius veiksnius ir barjerus, bei pagrindinius AI diegimo įmonėje elementus. Tuo remiantis buvo sukurtas konceptualus strateginio AI diegimo SVV įmonėse modelis , kuris išskiria elgesio kodeksą kaip pagrindinį AI formalizavimo elementą. Remiantis empiriniais rezultatais,

validuotas pasiūlytas konceptualus modelis ir jo elementai nagrinėtame kontekste Buvo nustatyti du papildomi pagrindiniai strateginio AI diegimo elementai – pasiekiamos AI diegimo naudos arba konkurencinis pranašumas bei atsakomybės vertinimas vertės grandinėje. Be to, nustatyti du dominuojantys strateginio AI diegimo profiliai susiję su asmenine įkūrėjo motyvacija ir vertybėmis bei darbuotojų įtraukimu į strateginius procesus ir sprendimus.

Table of contents

List of figures

List of tables

List of abbreviations

AI – Artificial Intelligence

CSR – Corporate Social Responsibility

ECG – Economy for the common good

EU – European Union

ICT – Information and communication technology

IoT – Internet of Things

IP – Intellectual property

KPI – Key performance indicator

OECD - Organization for Economic Co-operation and Development

OI – Open Innovation

R&D – Research and development

RRI – Responsible Research and Innovation

RI – Responsible Innovation

SDG – Sustainable Development Goals (by the UN)

SME – Small and medium-sized enterprise

UN – United Nations

VC – Venture Capital

Introduction

Relevance

Innovation is widely seen as a positive process contributing to economic growth, prosperity, quality of life and societal progress (Tidd & Bessant, 2018). This increases the pressure on companies to innovate and stay competitive in the long run. In the EU every second company engages in innovation activities (EuroStat, 2017). However, innovation can have a double face and may also have (unforeseen) negative effects, e.g. on the environment or society (Godin, 2015).

Major global challenges such as the climate crisis are caused by these negative innovation side effects. Therefore, governments or institutions like the UN pursue efforts to achieve higher sustainability and contribute to solving these major challenges by publishing sustainability goals (United Nations, 2020). In addition, pressure from consumers is growing for more sustainable products and transparent supply chains. These rising state regulations and consumer pressure demand products/services that have a positive impact on environment and society, while solving problems without creating new ones (Hin et al., 2015).

The concept of Responsible Innovation is defined as "a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view on the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)" (Schomberg, 2012, p. 50). Responsible Innovation (RI) is a new concept developed to reach this goal of acting responsible with special focus on innovation development. It aims at preventing negative innovation consequences on society and environment by broad stakeholder inclusion in the innovation process (Owen et al., 2012).

Problem

The RI concept gained popularity through EU promotion, which anchored it in its Horizon 2020 research framework. While the main focus of RI research was done by researchers and policy makers in the past, the concept is still very theoretical and does not provide concrete strategies on how to implement it in business practice (Auer & Jarmai, 2018). Some models and frameworks have already been developed on how RI could be applied in the company, but they are still very vague. Therefore the concept is also still very unknown in most of the companies although a large part of the innovations are not created in research, but through development in private companies (Lubberink et al., 2017). Thus, the implementation of RI in company strategies is highly relevant as it could lead to a competitive advantage and other positive effects such as better product-market fit, higher employee and customer satisfaction, and a better company image (RRing, 2020; Stahl et al., 2017). Benefits of the concept can be particularly significant in industries that are highly regulated and subject to stringent requirements (Stahl et al., 2017). Proactive compliance with requirements by following RI criteria can be a key competitive advantage.

This could be especially interesting in the context of SMEs as they tend to be more flexible in the adoption of new concepts (Jenkins, 2009). In addition, SMEs are to a large extend more driven by sustainability goals than by profit maximisation (Halme & Korpela, 2014). As SMEs activities to become more sustainable or responsible stay rather invisible compared to CSR activities of large companies, their motivation is more linked to the actual goal of being responsible than to only create a better company image (Jenkins, 2004). However, most of the research on RI application in the business context does not specifically address the case of SMEs.

The focus of the research on SMEs is relevant as 99% of all companies in the European Union fall under the category of SMEs[1], two thirds of all employees in the private sector work in SMEs, which contribute more than 50% to EU business value added (EuroStat, 2018). The difficulty SMEs face in adopting new concepts or strategies and the development of innovations may be the frequent lack of resources. In SMEs, many functions are not institutionalised and sometimes one person is responsible for several functions (van de Vrande et al., 2009). The overall strategy, marketing and innovation management in SMEs is often in the hands of the founder or managing director. But, there is evidence that these restraint resources might be beneficial for innovation and responsible SMEs find ways to overcome these shortages in resources (Bos-Brouwers, 2009; Halme & Korpela, 2014).

To summarize the scientific problem, the concept of RI gained attention in research due to the high societal relevance and possible company benefits of the concept. But strategic RI implementation frameworks for the business context still lack clarity and especially applicability in the case of SMEs, which are the most common form of business in the EU. Therefore, the development of concrete suggestions on how to strategically implement RI in SMEs to leverage the benefits that come with the concept is especially relevant and the subject matter of this research.

The **object of the research** is the strategic implementation of Responsible Innovation in biotechnology SMEs.

The **research aim** is to ground a conceptual framework for strategic implementation of RI in biotechnology SMEs.

To achieve the research aim, the following **research objectives** were set:

1. To analyse the situation of RI implementation in academia and business context with special focus on SMEs.
2. To perform a theoretical analysis of strategic implementation in SMEs with regard to RI by identifying its main drivers and barriers.
3. To develop a conceptual framework for strategic implementation of RI in SMEs based on the conceptualized relationships between the purpose level, innovation process level and the outcome level.
4. To substantiate a methodology for analysing the strategic implementation of RI in the biotechnology sector in Germany.
5. To empirically validate the strategic RI implementation framework in SMEs and extract dominant profiles of strategic RI implementation in biotechnology firms.

Methodology

This thesis is following a deductive research approach. In the first part of the thesis the relevance of RI and the research problem are elaborated. Secondly, the development of a conceptual framework for strategic implementation of RI in SMEs is discussed in order to achieve a result that is aligned with the research aim. This is based on an extensive literature review and comparative analyses of the individual elements of the framework to be developed. The focus is on RI literature on main elements and implementation frameworks of and SME specific literature on strategy implementation, innovation management, implementation of related concepts and drivers and barriers of RI implementation. In addition, characteristics of strategic implementations are defined. Based on the

[1] The European Commission defines SMEs as those enterprises employing fewer than 250 persons that have a turnover of less than 50 million euros and/or a balance sheet total of less than 43 million euros; EuroStat (2018).

findings of the literature review, a conceptual framework for the strategic implementation of RI in SMEs is proposed.

To test and validate the developed conceptual framework for its applicability, biotechnology firms were chosen as a research context as the benefits through strategic implementation of RI can be especially high due to the highly regulated nature of this sector. As a qualitative research method, the case study method was chosen and a guideline for semi-structured interviews based on the framework elements was developed. Data was collected through five semi-structured interviews conducted with CEOs and innovation managers of biotechnology SMEs in Germany and additional secondary data acquired by desk research on the firms' activities and external presentation. Using the software MAXQDA, a qualitative content analysis of the data was performed to validate the elements of the proposed conceptual strategic implementation framework for RI in SMEs. The results are presented and discussed in the final part of the thesis, followed by the limitations and recommendations for further research and the main conclusions on strategic implementation of RI in biotechnology SMEs.

1. Problem Analysis of RI implementation in SMEs

Most positive developments in our society and day to day life are based on innovations. Therefore, innovation is widely seen as a positive process that contributes strongly to economic growth, prosperity, quality of life and overall societal progress (Tidd & Bessant, 2018). This is also shown by the high prevalence of innovation activities in companies in the EU member states, with around 50% of companies engaging in various innovation activities (EuroStat, 2017).
However, innovation can have a double face and is not inherently good. On the one hand is solves problems, initiates, and generates value, but on the other hand it can also have negative consequences and cause new problems (Godin, 2015). There are many historical examples of negative side effects of innovation, which include the insulating material asbestos, nuclear power or the herbicide glyphosate (Kormelink, 2019).

Glyphosate was developed in the 1970s as a new generation of plant protectives. It was considered to be particularly effective and at the same time to have a lower side effect on flora and fauna due to a lower mobility and shorter life span. The positive effect is certainly the possibility of practising field farming even under difficult conditions and significantly increasing the yield per area, which can make a strong contribution to tackling the problem of food shortages (Bolwell, 2019). But later, there were repeated reports of possible carcinogenic and mutagenic effects of glyphosate, which were denied by the chemical manufacturers. To date, scientists disagree about the carcinogenic effect of glyphosate, but some countries have announced a ban. At the same time, the producers Bayer/Monsanto have already had to pay substantial compensation following rulings by US courts, as they had not warned of possible harmful effects (Hals & Bellon, 2021).
Thus, it can be said that innovation does not generally bring only good effects with it. These negative examples could be described as irresponsible innovation, which is a “product, service or business model that causes a new social or environmental problem or worsens an existing one” (Halme & Korpela, 2014, p. 548). In the light of these examples, responsibility in innovation management has long been an issue that gained higher visibility with the emergence of new technologies.

1.1. Institutional efforts to achieve responsibility

The emergence of new technologies triggers many ethical and controversial questions and discussions, as it comes with unknown future risks. This becomes increasingly clear when looking at potential future developments in the fields of artificial intelligence, nanotechnology, genetic engineering, autonomous driving and autonomous weapons systems, big data analytics and many more (Kormelink, 2019).
While these technology fields were emerging, the idea of *responsible innovation* was born. The development was especially pushed by new research methods and fields in the area of genomics (Owen et al., 2012). Research into genetic engineering, both on animals and plants, but also on humans, offers very far-reaching possibilities for development and also consequences at a wide variety of levels on society. Suddenly, researchers were confronted with complex ethical and moral issues that required a broader societal discussion. These profound decisions in research could no longer be made by researchers alone against the background that the research results could also have extremely negative future consequences (Schomberg, 2012).

Policymakers also struggled with the question of where the limits of research should lie. Up to what point is genetic research beneficial and at what point do we cross borders that may have unforeseeable negative effects on environment, society and future generations? The previous tools of researchers, policymakers and also companies were no longer able to help in a sufficient way. So far, the concepts of *technology assessment* and *sustainable development* have been pursued, as well as *corporate social responsibility* in companies. All these concepts have their justification for existence and are important building blocks for assessing and enabling responsible decisions and actions.
On the issue of genomics, for example, these existing concepts did not go far enough. It required a holistic assessment of the ethical questions. In this case, technology assessment would classically have been used in some form and various groups of people and experts would also have been involved with their assessment. The limiting factor here, however, was that these groups of people were still selected, so they were not completely unbiased (Pellé & Reber, 2013). A new, holistic approach to assessment was needed that took into account all aspects of responsibility, sustainability and impact on society. This is how the concept of Responsible Innovation came into place and became well known.

In 2013, the EU put the topic of Responsible Innovation on the research agenda of its Horizon 2020 programme in order to promote discussion of these important questions in connection with innovation. Together with the Horizon 2020 framework, the European Commission also published its Grand Societal Challenges, which are to be prioritised for funding and solved through innovation:

- "Health, demographic change and wellbeing;
- Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the Bioeconomy;
- Secure, clean and efficient energy;
- Smart, green and integrated transport;
- Climate action, environment, resource efficiency and raw materials;
- Europe in a changing world - inclusive, innovative and reflective societies;
- Secure societies - protecting freedom and security of Europe and its citizens" (European Commission, 2014).

To better achieve these goals, the European Commission sees Responsible Innovation as a particularly important and necessary concept, to align research and innovation with the societal needs. By using RI and implementing stakeholders at a very early stage, the European Commission sees the huge benefit "to obtain relevant knowledge on the consequences of the outcomes of their actions and on the range of options open to them […] to effectively evaluate both outcomes and options in terms of societal needs and moral values and to use these considerations as functional requirements for design and development of new research, products and services" (European Commission, 2013, p. 3).

In addition to the EU Grand Challenges, another more recent EU target also leads to greater relevance of RI. The "European Green Deal", announced and decided by the EU in 2020 is a concrete and target oriented action plan to achieve (1) zero net emissions of greenhouse gases by 2050, (2) an economic growth that is decoupled from resource use and (3) that no person and no place is left behind in this development (European Commission, 2020a). This last goal (3) in particular requires a development that includes the RI concept, as this allows for a holistic assessment and development in which no one is disadvantaged.

It is not only the EU that has set goals and measures for a sustainable and responsible future development. The United Nations developed 17 "Sustainable Development Goals" as goal for 2030 (see Fig. 1). These goals reflect the major global challenges of our time including e.g., poverty and hunger, environmental sustainability and fighting climate change and equality regarding education and gender (United Nations, 2020). Goal number 12 demands "responsible consumption and production" and is one of the goals that concerns business practice the most, as it affects almost every industry and every business (see Fig. 1).

Fig. 1. The 17 UN Sustainable Development Goals (United Nations, 2020)

While these goals are not binding for UN member states, some country governments have (partially) integrated these goals into their government programmes, e.g. Germany (Die Bundesregierung, 2020). In their sustainable development strategy, Germany sets targets for each UN SDG goal. For the economy, this relates in particular to targets for more sustainable production and steps towards the circular economy, the reduction of emissions and compliance with these standards in supply chains in other countries around the world (Die Bundesregierung, 2020). As with the EU, the UN and countries like Germany see innovations as one of the most important building blocks for achieving the sustainability goals that have been set. At the same time, they also agree that these innovations must be responsible. In other words, as previously described, they must solve problems without creating new problems for society or the environment or worsening existing problems (Halme & Korpela, 2014).

1.2. Relevance of responsibility in innovation management

But not only in policy development, also in the societies worldwide there is growing awareness and concern about climate change, scarce resources and social inequality. Global movements for climate action, such as the "Fridays for Future" protests gained large visibility and support for their claims on taking measures to fight the climate crisis (Road, 2019). This growing perception of sustainability is also increasingly influencing consumers' purchasing decisions. This applies for example to groceries, cosmetics, cars and fashion, but also to many other industries. In Germany almost two-

thirds of respondents (64%) in a 2018 survey considered “environmental protection and climate change mitigation to be a high-priority challenge” (Umweltbundesamt, 2019). This was 11% more than the participants reported in a study two years earlier.
But this trend towards greater sustainability awareness is not only a local phenomenon. The awareness of sustainability and the related issues and necessary actions is growing globally (World Economic Forum, 2019). During the COVID-19 pandemic, this trend was even further accelerated. In a global study conducted in Brazil, China, France, India, Indonesia, South Africa, the UK and the US, 70% of the participants stated, that their awareness for environmental awareness is higher than before the pandemic (Kachaner et al., 2020). 87% of the participants stated that companies should integrate environmental concerns into their products, services, and operations to a greater extent than they have in the past. These demands come particularly from younger generations, who also increasingly want to contribute to more sustainable development through conscious purchasing decisions.

To meet the demands sustainability-oriented target groups, more and more companies are also pursuing sustainability goals. This is usually done within the framework of CSR initiatives or sustainable development. For many companies, the motivation for such sustainability initiatives lies in the goal of improving economic performance (Bos-Brouwers, 2009). In Germany, almost 50% of companies in a 2018 study stated that sustainability is the corporate strategy (Institut für Arbeitsmarkt- und Berufsforschung, 2019). The growing trend of consumers wanting to buy sustainable products will certainly increase the percentage of companies actively pursuing sustainability strategies in the future. Companies pursuing a CSR strategy usually actively use their responsibility actions to promote their image and to increase sales. But does a sustainability strategy also mean that a company or a certain product is sustainable? With increasing pressure for sustainability, reports of green marketing or greenwashing are also becoming more frequent.

Greenwashing involves actions of organizations or companies that make the customer think that they care about the environment, by marketing environmental benefits of the product, even if the core business harms the environment (Seele & Gatti, 2017). Typical examples for greenwashing are from the hotel industry, where guests are asked to use their towels for another day with the addition that this protects the environment. In reality, most hotels introduced this as a way to reduce their costs of cleaning towels (Pimonenko et al., 2020). Other prominent examples include fashion items that claim to be recycled, but only contained few percentages of recycled material (Henninger et al., 2016).

One of the examples of why RI is also so important in companies is the Volkswagen scandal, which was uncovered in 2015. In 2014, during checks of the emission values of diesel vehicles, deviations from the stated emission values were recorded in road and laboratory tests. It later became clear that engineers had developed special software that recognised the control runs for emissions measurements and then reduced engine performance and emissions values. This technology was installed in more than 500,000 diesel vehicles (Siano et al., 2017). It also became clear that various members of the management knew about it.
Consequently, the car manufacturer’s share prices dropped significantly, and Volkswagen had to pay billions in compensation in various lawsuits around the world. At an additional cost, the company’s image suffered massive damage (DW, 2020). Furthermore, many buyers of the cars have also suffered financial damages that have not been compensated, as their cars, which they bought believing they were environmentally friendly, have greatly decreased in expected resale value.

Summing up the negative examples mentioned, it can be stated that the increasing pressure for more sustainability either overwhelms many companies or they do not take it seriously enough to initiate a real sustainable change process. In addition to consumer pressure, there are also growing regulatory standards that are decided by policymakers. These concerns for example regulations on recycling, reduced emission levels or even certificates or penalties for excessively high emission levels. At the same time, a firm's priority is always profitability, which is sometimes difficult to reconcile with sustainability. Thus, the latter among other things led to the Volkswagen scandal.

RI can be used to minimise these uncertainties regarding the market adoption of innovations and to identify potential undesirable negative impacts at an early stage. Through RI, greater involvement and cooperation between scientists from different disciplines, societal actors and citizens is promoted in order to achieve a broader dimension of science and innovation to achieve improvements for society and better environmental preservation.

Recent examples of innovation involving RI values are contact tracing apps developed e.g. in Germany and the UK, to tackle the COVID-19 pandemic (van den Hoven, 2020).
The rapid and unpredictable outbreak of COVID-19 quickly overwhelmed the contact tracing capabilities of health authorities worldwide. Since this lack of traceability, especially among pre-symptomatic or asymptomatic patients, threatened an enormous growth of infections and thus also a large number of severe cases or deaths, many countries worldwide were under great pressure. In the shortest possible time, a way technology had to be developed to ensure contact tracing when case numbers are high and health authorities are overwhelmed, as well as to have a useful tool for tracing contacts once social distancing restrictions have been lifted and more people are meeting again. The technical possibilities offered by contact tracing via digital tools such as the smartphone, e.g. GPS and wireless communication, enable a complete and rapid tracing of infections to be achieved. But these tools trigger a complex set of ethical hazards that intensify the increasing challenges to autonomy, privacy and public trust that citizens in general already face in a connected big-data society (Leslie, 2021). On the other hand, there are economic pressures and social concerns triggered by long-lasting restrictions and lockdowns.
In Asia, where the first outbreaks occurred, great successes were achieved in controlling the pandemic with different approaches of AI-based contact tracing. However, this is not without controversy, because in China, for example, all available private data is evaluated in a non-transparent algorithm and a risk profile is created based on this, which allows or revokes privileges for the user depending on their risk status. Other Asian countries have adopted similar approaches, using all data for the benefit of public health while totally sacrificing personal privacy.
In Europe the apps came out later and were inspired by the technology of decentralised collection of anonymised IDs via Bluetooth introduced in Singapore. In Germany and the UK, however, the difference is that the app does not give the user direct freedoms in daily life, nor is it obligatory to use or warn one's contacts after confirmed infection via the app (Leslie, 2021). As people in Europe tend to be more concerned about data privacy, countries like Germany or the UK followed a responsible development process to avoid negative future consequences and to achieve a higher acceptance of the app in the society (Zhao et al., 2020).
In Germany, the development process involved a public discussion and broad integration of opinions on the general concept of the app. The development was carried out in a collaborative process led by Deutsche Telekom and SAP. In the coding process the source code was publicly posted on GitHub to receive feedback from the community. As a result, the data is fully anonymised and stored

decentrally on the user's device, so that the user cannot be identified in any way. The focus in the design process on maximum security and privacy with simultaneous functionality and open source led to a high number of downloads of early adopters after the app's launch. Even if the app is not quite as successful as desired (measured by downloads and active users), the app can still be seen as the success of a responsible development process, democratised as an open-source project, with the data security of the citizens as the top priority and fully barrier-free through inclusion (Deutsche Telekom AG & SAP SE, 2020).

The case of the app development shows that a responsible development process to achieve ethically and socially desirable products is possible in practise, even under such enormous pressure during a pandemic. It was possible to deal with the hazard of the pandemic, democratically involve stakeholders to minimize future risks or negative outcomes and to equally distribute the benefits delivered by application. This example and others from the field show that RI can be a suitable instrument for developing innovations that are compliant with the UN SDGs.
Through a broader use of RI in the development of innovations - beyond academia and research also in companies - future negative consequences of these developments, such as the examples mentioned above, can be avoided. RI is an important tool, as previous methods of assessing technology, ethical issues and responsible action have not been sufficient to identify and include all relevant perspectives and future risks. In addition, there are indications that RI can help to gain a competitive advantage, as will be described later in this thesis.

Through greater awareness and widespread use of RI in business practice, there could be a better chance of addressing the big issues of our time, such as the UN SDGs or the EU Grand Challenges, more effectively and sustainably, without leaving anyone behind. As business is responsible for a significant part of innovation and its commercialisation, it also has a major impact on the achievement of these goals. Although consumer pressure for more sustainable companies and their products is growing, and governments are also gradually demanding stricter rules for sustainability and responsible action, research into RI in the business context can also make an important contribution.

1.3. Practical problem of the RI implementation in SMEs

The major problem of RI research is the unpopularity of the topic. RI is mainly discussed in academia and therefore largely unknown in the industry (Auer & Jarmai, 2018). Application models were mainly aimed at policy or research settings and the application in business practice just started to develop, however, primarily with a focus on large companies. Therefore, the definitions so far are mainly based on theory, focussed on responsible research and less on applied RI in practice.

The unawareness of the topic – especially in the business sector – also makes quantitative studies difficult. At the same time RI is already partly implemented as it combines different strategies, approaches and instruments as an umbrella term (Ladikas et al., 2019). In addition to the unpopularity of the RI concept in practice, the still very vague frameworks for implementation in practice are also a problem. So far there are only a few frameworks/conceptual models and most of them are developed for a specific industry (Stahl et al., 2017). Thus, there are no concrete recommendations on how RI should be implemented in practice.
Due to the many overlaps of RI with other concepts (see 2.3.2), many companies must first carry out an as-is analysis to identify which steps are still necessary to implement RI (Auer & Jarmai, 2018).

Carrying out such an analysis is especially difficult in SME settings, where resources in general are very often limited (Halme & Korpela, 2014). This makes it difficult to deal intensively with a new topic or a new strategy that is not yet well developed in theory, as it could provide concrete recommendation on how to implement it in a company or specifically in an SME. Therefore, more research is needed on RI in the business context of SMEs, as their characteristics also require a special development approach.

As SMEs are the most common form of business in the European Union, they also contribute largely to the EUs economic performance in terms of employment, innovation and export promotion. They are also considered to be a driving force when it comes to innovation although they face constraints regarding access to financial resources and their ability to establish organizational structures for specific functions (Auer & Jarmai, 2018). While large companies have broad sustainability initiatives and strategies, SMEs do not have such a strong sustainability agenda (Pavie et al., 2014). One of the main reasons for this is that SMEs do not have as much public visibility and interest as large companies and therefore highly visible sustainability initiatives do not provide a directly measurable economic benefit.

To conclude, the RI concept is still relatively unknown in practice and there are only still few concrete examples of its application, academia needs to contribute to creating scientifically based evidence, incentives and motivation for SMEs to integrate the RI concept into their corporate policies and strategy. Especially as there is a growing pressure from society and institutions to integrate responsibility into innovation processes. The focus must be on SMEs, as they have a significant share of the economic power and innovative strength in Europe, but naturally face barriers in the adoption of new concepts. Thus, a wider implementation of the concepts by SMEs can contribute to solving the Grand Challenges such as the UN SDGs.

2. Theoretical Solutions for strategic implementation of RI in SMEs

2.1. Strategic implementation

To implement a concept such as RI strategically in the company, it is first necessary to define what strategy and strategy implementation mean. Strategy in a company context can be defined as the search for a favourable and sustainable competitive advantage against competitors in the industry (Porter, 1996). Companies usually develop a corporate strategy to improve their competitive position, build up competitive advantages and thereby achieve above-average profits (Hitt et al., 2017). However, the definition of strategy itself varies across schools of thought and depends on the field or assumptions of the authors (Hafsi & Thomas, 2005; Jarzabkowski & Wilson, 2006).

Since Chandler's idea whether "structure does follow strategy" (A. D. Chandler, 1962, p. 14), strategic management has been described by multi-stage process models connecting strategy with organizational structure. In the past, the literature has focused on strategy formulation rather than implementation, although this is critical to the success of the strategy (Aaltonen & Ikävalko, 2002). But strategy implementation logically follows a preceding process of strategy development and formulation and both elements although they can be clearly delineated both are important (Hrebiniak & Joyce, 2005). The connection between strategy formulation and implementation also becomes clear as in the formulation phase the organizational variables have an impact on the strategy, whereas in the implementation phase the strategy influences the organizational variables (Homburg et al., 2004). Therefore, the entire strategic management process must be considered when defining and differentiating the individual stages.

The strategy formulation is based on an extensive analysis of the company's external environment and the industry in which it operates. In the course of this analysis, a corporate mission and vision are usually formulated, which serve as a starting point for the detailed formulation of a corporate strategy (Hitt et al., 2017). Based on this analysis of the environment and the industry, as well as the company's mission and vision, a strategy is then selected or developed to strengthen the competitive position. This often involves the use of generic competitive strategies (Porter, 1985), but as already mentioned, the literature on strategy formulation is very broad.

Strategy implementation has the task to transform the strategic intentions into actions, the daily business and decision-making of a firm. Definitions of strategic implementation vary in literature. Most definitions focus on the process perspective of strategy implementation. In addition, in a comprehensive literature review, Yang et al. (2010) also identified strategy implementation definitions that focus on a behavioural perspective, as well as a combination of both perspectives.

For further use in this thesis, the definition of Harrington (2006) is chosen. He defined strategy implementation as "an iterative process of implementing strategies, policies, programs and action plans that allow a firm to utilize its resources to take advantage of opportunities in the competitive environment" (Harrington, 2006, pp. 374–375).

This area of strategic management research is still weak, but it is growing and there are some models and approaches for successful strategy implementation (Hrebiniak & Joyce, 2005). Nevertheless, the implementation of strategies in practice remains particularly challenging, even more so than the formulation, which is partly due to the fact that this phase of strategic management covers a much longer time period (Hitt et al., 2017). The greater the number of people involved in a strategy implementation process, the more complex it becomes (Hrebiniak & Joyce, 2005). This raises the question of how many and which people should be involved in the strategy implementation process. However, practical examples show that broad employee participation can also contribute to the

success of strategy implementation (Harrington, 2006). On the other hand, Gilbert (2005) describes that strategies based on ethical principles – such as strategies based on RI – have a higher success rate in strategy implementation and additionally have a positive impact on the long-term success of the strategy as it contributes to higher trust and commitment among all stakeholders of the company. Most of the literature on strategy implementation deals with organisational structures and how they can be optimally tailored to the strategy and the assessment of the results and performance of the implementation process (Priem & Cycyota, 2005). In addition to organisational theory, strategy implementation also includes tasks from the areas of organisational development, such as training, and organisational behaviour, such as reward systems. However, the theories of strategic management always apply as a basis, which also includes planning and performance monitoring (Hrebiniak & Joyce, 2005).

Other authors see strategy implementation from a different perspective and as an issue of gaining the commitment of the workforce or through intensive employee engagement and a strong corporate culture (Bourgeois & Brodwin, 1984). This is also in line with the findings of Yang et al. (2010), who identified a behavioural perspective of strategy implementation in addition to the process perspective. This behavioural perspective makes communication and employee engagement particularly important in the implementation process. According to Barrick et al. (2015), strategic implementation increases the relationship between organizational resources and collective organizational engagement. Therefore, involving employees in the strategy implementation process can increase the success of the strategy and improve firm performance in general, as they are more motivated by shared values.

In summary, four major characteristics could be identified when dealing with strategic implementation. Strategic implementation is a challenging part of the strategic management process that builds on the formulation of a strategy as well as a *corporate mission and vision (1)*. Strategy implementation is an *iterative process of change and control (2)*, whose success depends heavily on the behaviour of both management and employees and is strongly influenced by the corporate culture. In contrast to implementation, strategic implementation is an iterative process that aims at developing *advantages in a competitive environment (3)*, while the strategies being implemented are defined by *policies or action plans (4).*

2.2. Innovation implementation in SMEs

2.2.1. Generic innovation implementation process

Innovation is key to economic success, growth and a competitive advantage. The latter can be connected to size, complementary assets or other factors. However, there is a greater chance of developing a competitive advantage for those companies that can combine knowledge, technology skills and experience in a process to develop new products/services (Tidd & Bessant, 2018). Therefore, innovation is embedded into the strategy of many companies.
Innovation is defined as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (OECD, 2009, p. 11). The important aspect of definitions of innovation is the implementation or commercialisation aspect which distinguishes innovation from an invention. Innovation management has gained much popularity in academia and management practice in the past decades, so that many companies have strategically integrated and institutionalised innovation as a process within the company (Bucherer et al., 2012). This innovation process can look differently for each organisation, depending on the firm's environment (industry, product, etc.) and the company itself (size, vision, etc.). As a generic model this innovation process usually comprises at least the four stages *Search*, *Select*, *Implement* and *Capture* (see Fig. 2).

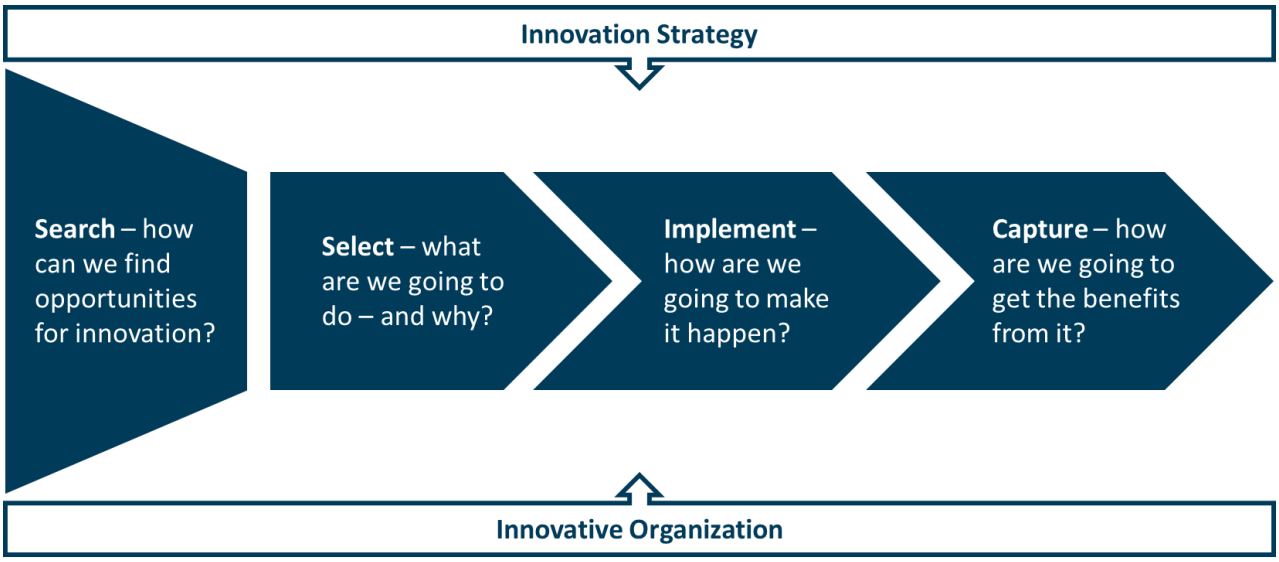

Fig. 2. Model of a generic innovation process, adapted (Tidd & Bessant, 2018, p. 49)

In the *first phase*, the *fuzzy front end*, the focus is on the effective generation of ideas and identification of opportunities for innovation. This phase is characterised by a particularly high degree of uncertainty, e.g. regarding the likelihood of success of the innovations (Gassmann & Schweitzer, 2014). The *second phase* of the process aims to minimise this uncertainty. This includes an analysis of the market potential, an assessment of whether the innovation can be developed with the existing competences and a decision on whether it fits into the (innovation) strategy and positively contributes to overall business performance (Tidd & Bessant, 2018). The *third phase* of implementation contains the actual (product/service) development of the innovation and can therefore vary largely depending on the context. It is typically the most time consuming and costly part of the innovation process, starting with the concept and ending with the launch/commercialisation. In this phase the concept is

narrowed down even more, knowledge is acquired, and the final (product/service) design put into reality. This can involve (depending on the type of innovation) marketing activities such as intensive market research and sales efforts, product design and testing and the development of a supply chain and manufacturing process (Ulrich & Eppinger, 2012). Depending on how knowledge-intensive and technology-intensive the innovation is, an R&D function also contributes to development. In addition to these core functions for the innovation process, almost all other functions of the company are also involved together with possibly also external partners or users, which requires precise coordination and regulated processes. This stage is characterized by many problem-solving feedback loops, which makes a linear process model unrealistic and not fully adequate, yet this representation is often used (Tidd & Bessant, 2018).

One of the most common Innovation process models for this stage of the innovation process is a Stage-Gate model. The model "breaks the product innovation process into a predetermined set of stages, each stage consisting of a set of prescribed, cross-functional, and parallel activities" (Cooper, 2011, p. 1). Each stage requires to pass a decision gate, a checkpoint for a go or kill decision, based on preselected deliverables and evaluation criteria (Cooper, 2008).

The *fourth phase* of the innovation process is about capturing value from the innovation – economically, complementary assets or other sort of improvement of the competitive position. In addition, the reflection and learning from the overall previous process is important to enable a continuous improvement of the innovative capabilities of the organization.

In summary, these generic innovation models are just a theoretical foundation, but many companies are using them as a basis for developing their governance systems for innovation implementation. For this purpose, usually those functions relevant to innovation in the company are institutionalised and controlled by a form of innovation management. However, the development and institutionalisation of an innovation management system requires clear segregation of functions and sufficient financial resources, characteristics that many SMEs do not have.

2.2.2. Characteristics of innovation implementation in SMEs

Managing innovation in SMEs must be distinguished from the traditional innovation management that is often used in larger companies. For SMEs, the development of innovations is of high importance in order to grow and survive and an important driver to achieving a sustainable competitive advantage (O'Regan et al., 2006). But some factors often limit the development compared to large firms. These limiting factors include financial constraints and manpower bottlenecks in terms of numbers of employees and limited specially qualified personnel (Tidd & Bessant, 2018). On the other hand, SMEs have some beneficial characteristics for innovation, as they are often less bureaucratic, which makes quick decisions and rapid actions to adapt to changing environment possible (Vanhaverbeke, 2017).

However, as many SMEs invest less in expensive R&D projects, they need to exploit existing resources such as their human capital to generate innovations (Wang et al., 2010). In addition, many SMEs do not have a broad product portfolio and cannot rely on other products (cash-cows) to compensate innovation efforts (Pullen et al., 2009). This is also why the often used innovation funnel concept is difficult to apply in SME settings, as they do not have a portfolio of innovation projects to manage and innovation usually deals with the core business (Vanhaverbeke, 2017). In many cases, innovation activities also involve complex risk assessments. SMEs often have limitations in dealing with complex issues and decisions that require more than technical or business know-how, a comprehensive and far-reaching (data) analysis (Pratali, 2003).

Consequently, innovation in SMEs is often not formalized or institutionalized and usually in the hand of the manager or founder of the company, which makes it an integral part of the overall business strategy. The manager often has very limited time to deal with other strategic issues (Thorn & Müller, 2006). Thus, the innovation implementation strategy is driven by innovation-based, entrepreneurial leadership with supporting tools and activities (McAdam et al., 2010). There are no clear findings in the literature on how exactly innovation processes should be designed in SMEs, which is mainly since research has predominantly dealt with large companies and innovation management. In addition, the implementation strategy also depends strongly on the respective firm environment and because SMEs are often active in very specialised markets, there are always very specific requirements for innovation development. However, there are indications of which tools and activities can lead to increased innovativeness in SMEs.

These include open innovation activities to share development risks and compensate for lack of knowledge or resources through research partners, where the SMEs ability to network internally and externally helps (Tidd & Bessant, 2018). Partners can be similar companies in the same sector, research institutes or universities, or even large companies (Vanhaverbeke, 2017). Another component is targeted knowledge management to use internal human capital and to drive creativity and specialised know-how for the development of innovations (Ferraresi et al., 2012). Lastly, various techniques for user-centred design are often mentioned, which should be used in the innovation process to increase success (Ulrich & Eppinger, 2012).

In conclusion, it can be said that innovation implementation in SMEs usually differs from what is described in the literature or done in large companies. Depending on the size of the SME, innovation management is not institutionalised and driven by executive engineers or the manager. Although this can also be a formalised innovation process (e.g. the stage-gate model), the number of innovation projects is also limited. Since SMEs still must develop innovations, some companies compensate for the lack of resources through open innovation initiatives, knowledge management or user-centred design techniques.

2.3. Theoretical Foundations of RI

Acting responsible as an organization has always been important but has gained special attention by the emergence of new technologies and the global problems that are now reasoning for the EU grand challenges or UN SDGs. Responsibility is a broad term that must be used in a certain context to be clear, whether it is a citizen, employee, or company. In this case, it is referred to the responsibility of an organization in the business context. Responsibility in the business context has always been described in three layers of responsibility, usually including moral, legal and contractual responsibility (Dillard & Alan, 2013). With regard to RI, Pavie et al. have added another dimension to the understanding which now includes four levels: Firstly, a firm creates responsibility with the creation of a company, including all its employees and stakeholders. Secondly, the company holds responsibility as a legal entity to follow legal regulations of the state and society it is embedded in. Thirdly, a company is responsible towards its (contractual) partners for example, to comply with agreements made. Lastly, a company is responsible regarding its impact on future generations (Pavie et al., 2014). As this last component is incredibly complex, companies aware of this responsibility tried to comply with this understanding of holistic responsibility of a firm. To meet these imperatives, it became clear that previous concepts were not always sufficient. Therefore, this fourth level of responsibility of a company builds the foundation for RI.

2.3.1. Definition of RI and its key dimensions

The concept of RI is derived from the broader concept of RRI, which refers to Responsible Research and Innovation. The adaptation of the term to RI refers to the application of the broader concept of RRI in the industrial context of business.
The term Responsible Research and Innovation (RRI) became visible around the year 2010 with first publications addressing the topic and defining the term in connection with ethical issues in research (Owen et al., 2012). The topic gained a great focus in research when the European Commission put RRI on the research agenda of the Horizon 2020 framework as they saw it as key element to solving the great societal challenges of the European Union (European Commission, 2013).

A definition for the concept of RRI has been discussed for years. But since RRI is a particularly broad concept and different emphases are placed on the understanding of the term depending on the perspective, definitions used to vary often somewhat depending on the context. The most widely used definition comes from von Schomberg in 2012 and is generally accepted as a working definition, although it is very vaguely formulated:

> *"*Responsible research and innovation is a *transparent*, *interactive* process by which societal actors and innovators become mutually responsive to each other with a view on the *(ethical) acceptability*, *sustainability* and *societal desirability* of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)" (Schomberg, 2012, p. 50).

While the focus of early research around RRI was on policy development and classic research, the focus of the last few years was also on the implementation of the RRI concept in business practice, generally understood as Responsible Innovation. It is important to distinguish the parts "research" and "innovation" in the RRI concept, as they stand for different goals. While research generally aims to explore science or new technologies and is often embedded in an academic or laboratory setting, innovation aims at commercialisation. Innovation usually takes place in businesses, is profit driven and aims at quick results. Therefore, the concept of RI, which is an objective of this work, differs from the general RRI term and is related to the implementation in business practise.
In addition to the most commonly used definition for RRI, there are a few more specifically addressing RI that are relevant to mention:

a) "Responsible innovation means taking care of the future through collective stewardship of science and innovation in the present" (Stilgoe et al., 2013, p. 1571).
b) "Responsible innovation [...] refers to a new or significantly improved product, service or business model whose implementation at the market solves or alleviates an environmental or a social problem" (Halme & Korpela, 2014, p. 548).

As these definitions lack real clarity and applicability, academia started to develop further explicit frameworks of RI that are applicable to specific case studies to promote the RRI concept further. In these processes different dimensions of RI were developed that varied depending on the research context. The most cited RI process dimensions of Anticipation, Reflexivity, Inclusion and Responsiveness were developed by Owen et al. (2013).

Anticipation: To anticipate the future of research and innovation and understanding how current dynamics may help to design the future. - This dimension means to picture and analyse any known, likely, possible and plausible impact (intended and unintended) that might come from the innovation that is to be developed (Lubberink et al., 2017). To assess available alternatives and become aware of different futures, this involves activities such as foresight, scenarios and technology assessment together with a broad inclusion of stakeholders to understand the dynamics and all potential problems that might arise (Owen et al., 2013).
Reflexivity: Reflecting on the impact of the company on society and environment, the companies purposes, motivations and values (van de Poel et al., 2017). Implementation of this reflection during the innovation process and other relevant processes in the company. Reflection on how existing values influence decisions and processes in the company (Lubberink et al., 2017). Examination of other prevailing values and opinions in society and integration of these in decision-making processes. This is again possible through the early involvement of stakeholders and the public, who deliberate about the innovation at stake.
Inclusion: This dimension is named differently in various articles, sometimes with the term "inclusion", sometimes with the term "deliberation" (Lubberink et al., 2017). It deals with engaging different (public) stakeholders in particular in the early stages of the innovation process in order to achieve a socially desirable outcome, including justice and equality. This involves democratic deliberation through dialogues and open public discussions and to interrogate social, political, environmental and ethical implications that the development of the innovation would cause.
Responsiveness: The ability to use the response of the collective processes to set the direction and eventually change the shape or direction of the innovation (Lubberink et al., 2017). It is an iterative, inclusive and open process of learning to adapt to the ideas of RI and a public involvement (Owen et al., 2013).

The concept of RI reflects on dimensions that go beyond the traditional dimensions of innovation, understood as both process and outcome, which would be the adoption, assimilation and exploitation of an economic value-added new product, service, process or business model (Crossan & Apaydin, 2010). RI also goes beyond the related concepts of CSR, eco-innovation, social innovation and frugal innovation (see 2.3.2) as it focusses on the goal, process and outcome (Lubberink et al., 2017). Therefore Blok and Lemmens (2015) defined the following stages of RI innovation development based on the general understanding of RI and the ideal pictured by the European Commission:

- **Input**: RI aims at solving grand challenges, such as the UN Sustainable Development Goals. Since the UN SDGs are more comprehensive and better known in the industry than the EU's Grand Challenges, this thesis will focus on the UN SDGs.
- **Throughput**: The RI innovation process should be transparent, interactive, democratic and mutually responsive.
- **Output**: RI outcomes are ethically acceptable, socially desirable and sustainable.

The fact that the RI concept focuses on the three levels of input, throughput and output shows that it is an overarching concept that targets all areas and levels of the company. This concerns the general business strategy, objectives, internal processes and regulations, the innovation process and ultimately also the products and the way they are marketed.

The definition and understanding of the RI concept do not come without problems. As the RI research is quite a young field of academia and most of publications were released after 2010, the understanding of the concept is still under development. In addition, the current RI concepts were mainly developed by researchers and policy makers, which is limiting the applicability for the business context (Lubberink et al., 2017). All based on a very vague but common definition and different perspectives on RI depending on the research context. The very vague definition of RRI emerged by the approach of the EU to develop a top-down strategy to implement RRI. But these different perspectives on RI are needed, as the "ingredients of RRI must be decided nationally or even locally according to local perspectives and needs" (Ladikas et al., 2019, p. 349). This requires the development of RI implementation suggestions specifically for the particular industry and micro environment (Gurzawska et al., 2017). This lack of experience from integrated RI in business practice also causes the discussions about different understandings of what good quality RI entails.
In addition, the main definitions and the understanding of RI in academia paints a very idealistic picture of RI. The suggested dimensions for example do not necessarily only have positive mutual relationships. While reflexivity and inclusion only support each other, greater anticipation could generate new conflicts such as the broad public participation in the innovation process may upset scientists who want to protect their autonomy or initial research orientations (Stilgoe et al., 2013). Looking at the goal of RI to only develop innovations that solve grand challenges, this is unrealistic to achieve. There is and will always be a need to solve problems that are industry specific and companies are naturally focusing on economic value creation (Blok & Lemmens, 2015). And due to the nature of a firm, it first needs to make profits to survive.
Regarding throughput factors, a transparent and democratic innovation process might be especially difficult in competitive settings, where competitive advantages are based on information asymmetries (RRing, 2020). Moreover, a democratic process is difficult because some players in the market have more influence than others. Finally, the outcome of innovation, especially how the market reacts, is not fully predictable.

2.3.2. Similarities and differences between RI and related concepts

RI builds on existing concepts and did not emerge as a completely new concept. Corporate Social Responsibility, Sustainable Innovation, Social Innovation are concepts that were present before and are much more integrated into business contexts. The significant difference of RI is the holistic combination of the values that are proposed in the concepts with a focus on the innovation process. In addition, RI connects the mentioned concepts with methods and practices such as Open Innovation and Frugal Innovation, which are together with the other related concepts and their connection to the RI concept elaborated in the following sections.

CSR

Corporate Social Responsibility (CSR) is an approach to improve the relationship between organizations and the societies with which they interact. It is "a view of the corporation and its role in society that assumes a responsibility among firms to pursue goals in addition to profit maximization and a responsibility among a firm's stakeholders to hold the firm accountable for its actions" (D. Chandler & Werther, 2014, p. 6). A core problem with CSR is that many firms use CSR to maximise their product sales through effective communication of their responsible actions, which can sometimes turn into greenwashing (see problem analysis) (D. Chandler & Werther, 2014). CSR is

also the most popular of the related concepts presented in this paper. This can be seen as every FTSE 100 company has some form of CSR agenda, while on the other hand, despite some broad definitions. the concept is remaining unclear (Dillard & Alan, 2013). It could incorporate a social, ethical and sustainable assessment of a company's actions, but most companies find their own way of defining CSR and their taken actions with a view on the companies goals (D. Chandler & Werther, 2014).
An essential difference between RI and CSR is that RI focuses on the critical assessment of social, ethical and environmental impacts during the research and innovation process from the early stages to the market (Kormelink, 2019). While the CSR concept is much broader, it focuses on much more general societal impacts and is usually not directly integrated into the innovation process. RI on the contrary aims at already anticipating the consequences of developed innovations and tries to avoid negative consequences in advance (Lubberink et al., 2017). This is a major difference as CSR often just deals with adjustment to existing standards and the elimination or compensation of negative impacts in a reactive process.

Sustainable Innovation

The concept of sustainable innovation originates from eco-innovation and in the course of its development has been used almost synonymously with many other terms such as "environmental innovation", "green innovation" or "sustainability-oriented innovation" (Jarmai, 2019, pp. 20–21). Sustainable innovation is now used here as the generic term. Companies are engaged in sustainable innovation both with economic and ecological motives (Lubberink et al., 2017). A sustainable innovation can be both a process or an outcome as a product, service or system that leads to "environmental and/or social benefits over priors version's physical life-cycle" (Hansen & Große-Dunker, 2013), basically replacing a less sustainable with a more sustainable solution. Preferably, sustainable innovations have no negative impact on the environment at all, such as innovations that apply to the circular economy (e.g. cradle-to-cradle) concept (Geissdoerfer et al., 2017). Both RI and sustainable innovation focus on an environmentally sustainable outcome. In addition, sustainable innovation takes the social dimension more and more into account regarding the innovation process and its outcomes (Lubberink et al., 2017). This makes the concept of sustainable innovation very similar to RI, nevertheless RI has its clear differentiation points. In contrast to sustainable innovation, where the focus is on more environmentally friendly innovation compared to its previous version, RI also takes a more general approach of questioning the status quo (Jarmai, 2019). In addition, the orientation of sustainable innovation towards the search for economic opportunities does not fully correspond with RI goals.

Social Innovation

The term Social Innovation is also understood and defined differently depending on the context and is used for both intentional and unintentional, and intangible innovations (Lubberink et al., 2017). Social Innovation aims at developing solutions for important social, community and environmental issues, often driven by the motivation of societal growth and a greater business sustainability (Antoniou, 2019). In the business context it is "explicitly aiming at the creation of social value and thus at positive social change" (Choi & Majumdar, 2015, p. 27). In contrast to RI, social innovation has already been widely researched and is a practitioner-based concept. RI and social innovation have conceptually common drivers and outcomes, as they both aim to address the grand challenges of society, such as social inclusion. In addition, stakeholder engagement in the innovation process also plays an important role in social innovation (Lubberink et al., 2017). On the other hand, the goals of

social innovation are broad and focused on social added value, where environmental sustainability can fall short in comparison with RI.

Frugal Innovation

The Frugal Innovation concept has evolved particularly in the context of emerging markets but is now understood as a broader approach that also applies for developed markets. Key attributes of a frugal innovation involve "substantial cost reduction", "concentration on core functionalities", and "optimised performance level" (Weyrauch & Herstatt, 2019, p. 22). It usually aims at a target group that could not afford the original version of the product and makes the product much more user friendly, without reducing its quality (van Beers et al., 2020). Although frugal innovations are not necessarily responsible innovations, there is great potential to achieve the dimension of inclusiveness through frugal innovation by involving low-income groups in the development process and local economic development by the products success. In addition, a reduced product design with higher functionality can also help to save resources and make the product more environmentally sustainable (Kormelink, 2019). If the growing middle-classes in the emerging markets demand the same product designs as purchased in the developed countries, it will by far exceed the available resources on earth.

Open Innovation

The concept of Open Innovation (OI) is defined as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation" (Chesbrough, 2012, p. 20). It basically aims at external cooperation during the whole innovation process to both profit from external ideas, technologies, etc. and also share e.g. licenses or ideas with other companies or use external markets to increase the innovative capabilities of a firm. OI is widely used in business practice (Bogers et al., 2018). The OI concept shares the common idea with RI that external knowledge and ideas are fruitful for the innovation process. However, in RI this is understood as democratic and broad involvement, whereas in OI the involvement of stakeholders in the innovation process is focussed on specific target groups that gain added value through, for example, know-how advantages (with exceptions such as crowdsourcing or open-source projects). A major difference between the two concepts is that OI serves the overarching goal of greater company success and is usually not directly linked to sustainable or social causes (Chesbrough, 2012).

In summary, RI differs from the concepts presented here in the sense that it goes beyond the respective goals and actions. At the same time, RI unites all the concepts above with their individual shortcomings in a holistic approach to responsible organisational action. Therefore, RI takes up the responsibility idea of CSR and links it with the goals of social innovation and sustainable development. Thus, RI strives to act responsibly in relation to both society and the environment. These concepts united especially influence the input and output factors of RI.

While previous concepts focused on improving products and their impact on society and the environment, RI is characterised by a questioning of the status quo, similar to Frugal Innovation, where products are reduced to their essentials, i.e. their functionality. During the process of innovation development, RI also incorporates Open Innovation, but in a democratic process which is a major characteristic of RI. The instruments of frugal and open innovation especially shape the responsible innovation process. In conclusion, RI intervenes in all areas of the company, from general strategy and processes to results and products and their impact. In this respect, RI combines the concepts presented here in an umbrella concept while avoiding the individual weaknesses.

2.4. Frameworks and strategies for RI Implementation

While the previously mentioned concepts that are linked to RI are already more or less established in business practice, in the case of RI there is still no concrete evidence on how to integrate RI in a firm. One of the main reasons for this is that RI has been developed and promoted mainly by researchers and policymakers. As a result, the concept is largely unknown in corporate practice, which makes a deductive research approach to developing a model for RI implementation particularly difficult. Thus, all RI frameworks or models developed so far are based on inductive research.
In order to develop a framework for SMEs to build a competitive advantage through RI, this chapter first analyses several integration frameworks and strategies for RI and second models for integrating related concepts in SMEs, as they have characteristics that make adapted concepts necessary.

2.4.1. Implementation Frameworks for RI

The models presented in this chapter were developed between 2013 and 2020 and are mainly based on extensive literature analyses of RI literature and publications on the related concepts which were mentioned in the previous chapter (see Table 2 for an overview of the RI implementation frameworks presented in this chapter). Implementation frameworks were selected based on keyword search and backward reference search based on RI literature review papers. The papers selected for this comparative analysis include models that were developed either generally for any organisation or specifically for implementation in the business context. Furthermore, the understanding of RI should be based on the RI used in this work, i.e. the definitions according to Schomberg (2012) and the fundamental dimensions of anticipation, reflection, inclusion and responsiveness.
At the end of this chapter, some implementation models are presented that relate more to the integration process itself and to which the aforementioned requirements for a framework do not apply. Nevertheless, they are relevant for this work.

Stilgoe (2013)
The first framework developed, that is still considered the cornerstone of the other models, is the one suggested by Stilgoe et al. (2013). It was developed in the context of a publicly funded research project to assess the reasoning for a controversial geoengineering project. The framework is based on the previous developed four dimensions of RRI, which include Anticipation, Reflexivity, Inclusion and Responsiveness (Stilgoe et al., 2013). To operationalize these dimensions, they were integrated into a stage-gate process with specific evaluation criteria, that were relevant for these RI dimensions, and a decision panel with persons from different professional backgrounds.
In addition, for each of the dimensions techniques and approaches have been identified to guide how RI applied in practice can meet its objectives. For anticipation, these techniques include foresight, technology assessment, scenarios and horizon scanning among other things. Approaches to achieve reflexivity are listed as multidisciplinary collaborations or trainings, embedding of social scientist and ethicists and codes of conduct. Various formats of involving both the public and experts, such as consensus conferences, focus groups, citizens juries and panels are listed for inclusion. In addition, there are also Open Innovation, deliberative polling and user-centred design. For the last dimension of responsiveness Stilgoe et al. mention the constitution of grand challenges and research programmes, regulations and standards, stage-gates and open-access among other things (2013). Especially the techniques mentioned for responsiveness show that this framework was developed in a process with policymakers and is not primarily applicable for the business context. This is also the

view of the authors and they also see their model as limited in terms of wider use in companies and other sectors and contexts. Nevertheless, this initial framework for applied RI is considered a cornerstone, especially regarding the operationalisation of the RI dimensions.

Lubberink (2017)

Lubberink at al. (2017) have taken a similar approach to develop a conceptual model of how RI can be implemented in firms. Based on a broad literature analysis of RRI literature and additional publications on practices from social and sustainable innovation, they operationalise their suggested dimensions of RI with key activities and concrete strategies that could be applied.

While other authors use the terms inclusion and deliberation interchangeably, the authors distinguish between the two terms and add deliberation as a septate RI dimension. This leads to an RI model with the dimensions anticipation, reflexiveness, inclusion, deliberation and responsiveness. From their research on activities in related concepts, the authors added the additional dimension of knowledge management as a key supporting activity to enable the integration and implementation of the other dimensions in the first place. They argue that for certain desired innovation processes and outcomes specialists knowledge is necessary, such as technological knowledge, to meet ambitious environmental sustainability goals (Lubberink et al., 2017).

Based on the literature review, these six dimensions were operationalised in a second step, including key activities and strategies as can be seen in the following table:

Table 1. Key dimensions of Responsible Innovation in the business context (Lubberink et al., 2017)

Anticipation	Reflexiveness	Inclusion	Deliberation	Responsiveness	Knowledge Management
Determining desired impacts and outcomes of innovation Preventing or mitigating negative impacts Development of roadmaps for impact	Actions and responsibilities Values and motivations Knowledge and perceives realities	Involvement of stakeholders at different stages (who and when) Provision of resources and capital (how) Raised commitment and contribution (how)	Two-way exchange of views and opinions Shared information and value criteria Support decision-making with regard to the innovation that is under consideration Decision-making power of stakeholders regarding the innovation process and/or outcome Feedback regarding the dialogue and explaining how the results are integrated in the innovation	Making sure that one can respond to changes in the environment Actual response to changing environments Addressing the grand challenges Mutual responsiveness	Knowledge creation and integration Knowledge developing, assimilating and synthesising

In contrast to the Stilgoe et al. model, the operationalisations here are clearly more practice-oriented and supported by more concrete techniques that could be applied in a company to achieve responsible innovations. Nevertheless, this model is not yet suitable for giving specific instructions for implementation to a manager. It is more of a very general RI toolbox, that does not suggest exactly where to start with RI implementation. Moreover, the model does not guarantee responsible innovations as a result of the innovation process, as outcomes are not assessed.

Stahl (2017)

Stahl et al. chose a slightly different approach in developing a model for implementation of RI in the business context. Knowing that many companies already engage in RI-like practices without even knowing the RI term or without explicitly following any RI strategy, the authors decided to develop a maturity model that helps to both understand the RI components and to assess the status (maturity) of RI implementation in the organization.

Regarding the understanding of RI, the authors start with the view on RI from the perspectives of purpose (motivation), process (activities undertaken) and product (outcomes) (see Table 2) and subordinate the respective RI dimensions in a second step (Stahl et al., 2017). Based on a broad research project, including interviews, a Delphi study and in-depth case studies, five levels of RI maturity were identified and validated with case companies of the ICT industry. This maturity model is applied in the following way: the individual RI components (see Table 2) are assessed with a maturity level (see Fig. 3).

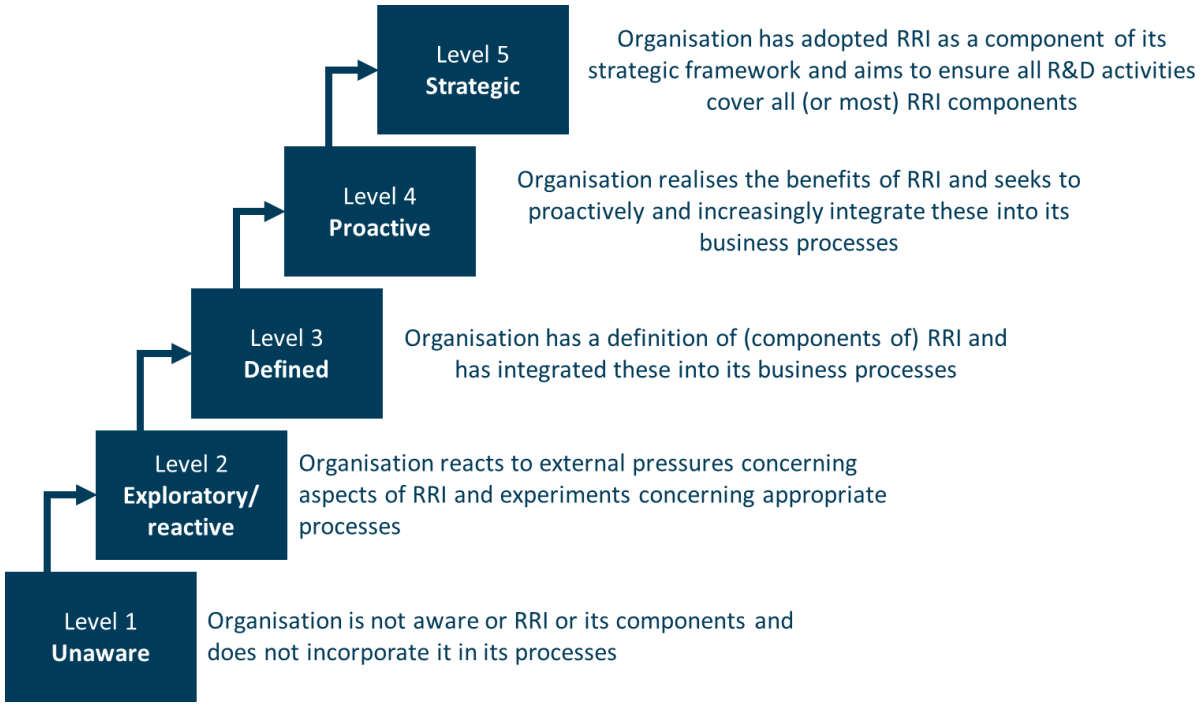

Fig. 3. Stages of the RRI Maturity Model (Stahl et al., 2017, p. 8)

The maturity model is a helpful tool to analyse the implementation of RI in firms and to compare them with each other. But, difficulties were encountered when testing the model. In order to evaluate a company in the model, internal expert knowledge (e.g. from an employee) is required. At the same time, it can happen that the employee does not know the RI concept, which is necessary to classify the maturity level (Stahl et al., 2017). This limits the model's broad applicability and suggests the development of a tool to self-assess the level of RI maturity.

Van de Poel (2017)

In their paper, van de Poel et al. (2017) have developed a conceptual model that aims to integrate RI into CSR policies and business strategy. In addition, the authors propose a process to develop KPIs for RI, as in strategic management, to measure RI outcomes. The model was developed and tested in the context of high-tech start-ups and SMEs.

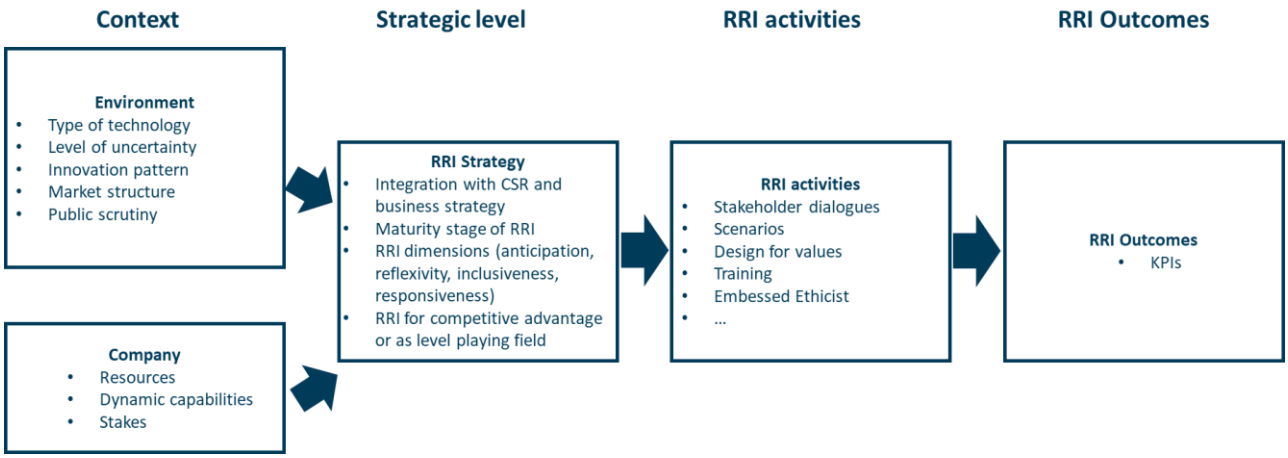

Fig. 4. Conceptual model for RRI in industry (van de Poel et al., 2017, p. 7)

In comparison with previously mentioned models, van de Poel et al. put the RI implementation in their model much more in the context the firm is operating in. In addition, the authors distinguish likewise Stahl et al. (2017) between the strategic level (purpose), the operational level (process) and the outcomes (product) (van de Poel et al., 2017). As a supplement to the conceptual model (see Fig. 4), explicit tools for each RI dimension are mentioned for the operational level. These tools are similar to the tools introduced by Stilgoe et al. (2013) and Stahl et al. (2017). Overall, the model proposed here is much more specific than the previous ones and offers the possibility to link RI to a specific context and to compare RI strategies of companies.

Fraaije (2020)

The implementation framework by Fraaije and Flipse (2020) was synthesised from earlier developed RI frameworks and a literature review, aiming at making RI more tangible for scientists and engineers willing to implement RI. The focus of the research was especially on the RI dimensions and their interconnections and influence on each other. In addition to the classical dimensions for the RI process, the authors identify a very important overarching RI dimension of transparency (Fraaije & Flipse, 2020). This refers to activities that contribute to RI process transparency by communicating the foundations of decisions, assessment criteria and the distribution of responsibilities among stakeholders and the public. It is additionally suggested to also be transparent and open about the limitations of the implementation of RI in the business.

In their model the relationships between the dimensions (see Fig. 5) are described, showing that each dimension is equally important for the implementation of RI. In addition, it is emphasised that all dimensions only have a positive influence on each other. For example, Reflexivity has no direct influence on the product, but influences responsiveness in a positive way.

In adding to the process dimensions, the authors also distinguish between three product qualifiers: societal relevance, market competitiveness and scientific quality (see Table 2) For each of the

dimensions/product and process qualifiers from the literature analysis are named and based on this, recommendations for action are given as to which individual steps should be taken to achieve responsibility in the entire innovation process.
This study may be somewhat limited in terms of practical applicability, as it focuses only on the analysis of dimensions, but it also gives some examples of practical activities to implement RI. However, these examples are also partly focused on research and not business practice. Nevertheless, it provides important discussions about the relationships between the RI dimensions.

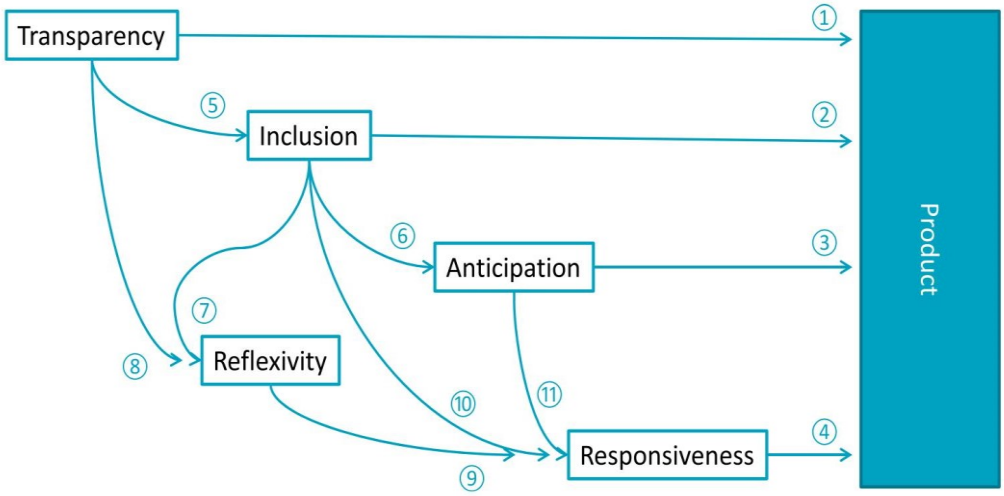

Fig. 5. Interactions among RI dimensions (Fraaije & Flipse, 2020, p. 120)

Gonzales-Gemio (2020)

In their study, Gonzales-Gemio et al. (2020) developed a conceptual model for RI that is aimed at SMEs. The literature review also focused on the relationship between RI and firm performance.
Like the models described above, this model also focuses on the classic dimensions of anticipation, inclusion, reflexiveness and responsiveness. Additionally, the dimension of knowledge management, which was first proposed by Lubberink et al. (2017), was identified as particularly relevant in the SME context where resources are inherently limited. The five dimensions identified are framed as the core of an RI strategy. Further, the authors describe so-called RI enablers, which are set up as prerequisites for implementing an RI strategy (see Fig. 5). They include "organisational flexibility", a "shared collective vison" and "Internal and external drivers" (Lubberink et al., 2017, p. 18). Similar to van de Poel et al. (2017), the context of the company (moderator) and the environment (control) are integrated into the model as „contingent variables" (see Fig. 5).
Moreover, the authors identify several connections between RI activities and tangible and intangible benefits that can increase the firm's performance. By integrating the firm performance into the model, RI activities have an impact on firm performance in some way. Therefore, it is also recommended to make the RI outcome measurable and thus to identify causalities between RI performance and firm performance.

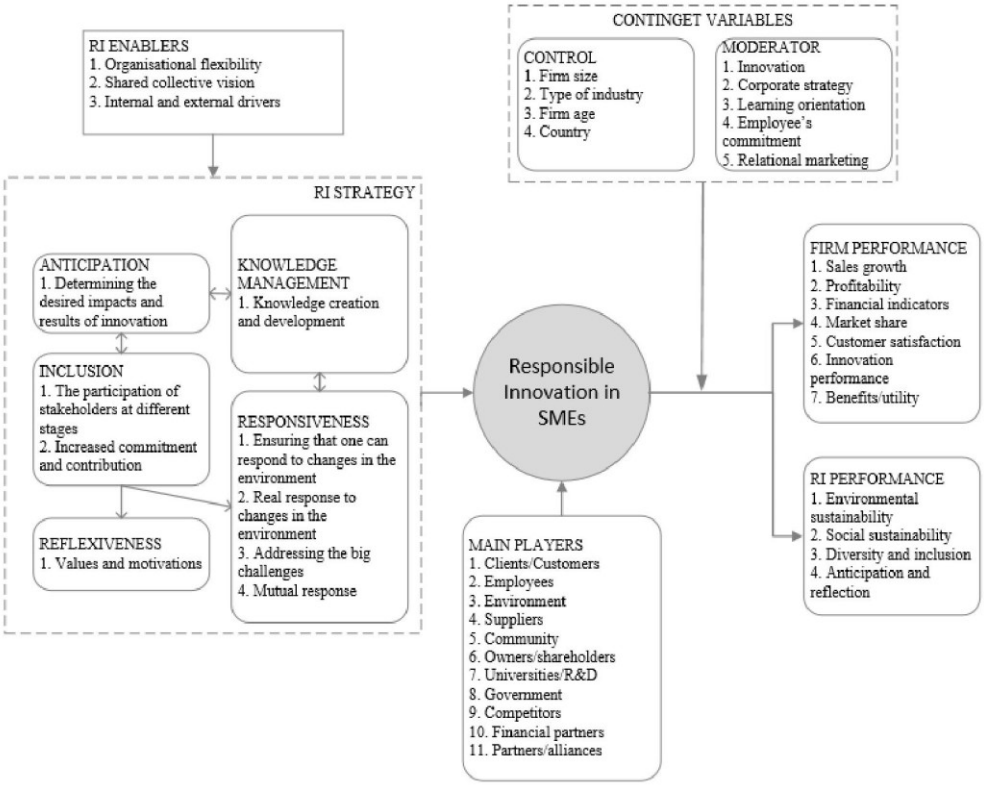

Fig. 6. Conceptual model of RI in SMEs (Gonzales-Gemio et al., 2020, p. 19)

Taken together, there has been clear progress in the development of RI frameworks over time. From the first framework, which was predominantly related to the innovation process (Stilgoe et al., 2013), a differentiation within the frameworks has developed towards (1) strategic level (purpose/motivation), (2) operational level (process/activities) and (3) the outcome level (product) (see Table 2).

For the strategic level (1) an integration of RI into the CSR policies and the business strategy is mentioned, together with the development and formulation of a clear vision and motivation towards the development of solutions to the grand challenges (van de Poel et al., 2017). In addition, RI enablers play an important role, which could be the vision of the manager in SMEs or other internal or external drivers (Gonzales-Gemio et al., 2020).

The process dimensions (2) Anticipation, Inclusion, Reflexivity and Responsiveness have proven to be the basic components for RI implementation and are used throughout all subsequent models. In addition, the knowledge management component has proven to be relevant, especially for SMEs, as the achievement of RI targets often requires specific knowledge (Lubberink et al., 2017). Transparency was brought into play as a second additional process dimension, as this is a basic requirement for the development of a competitive advantage through RI, both for the commitment of the employees internally and for the positive external effects (Fraaije & Flipse, 2020).

In order to implement the process dimensions in practice, many established methods and techniques were mentioned across all papers, e.g., to assess the consequences of innovations or to involve stakeholders.

For the outcome level (3) it is important to assess the RI results/products regarding their responsibility and impact on the overall firm performance (Stahl et al., 2017). Therefore, van de Poel et al. (2017) suggest the development of a comprehensive KPI measurement system.

Table 2. Comparative analysis of RI implementation frameworks

Authors/ Concept	Integration levels	RI Dimensions / Components / Qualifiers	Research Context
Stilgoe et al. (2013)	Indicative techniques and approaches per dimension; Stage-Gate Process	Anticipation, Reflexivity, Responsiveness, Inclusion	Geoengineering
Lubberink et al. (2017)	Operationalisation of each dimension with key strategies and activities	Anticipation, Reflexiveness, Inclusion, Deliberation, Responsiveness; additional suggested activity Knowledge Management	Broad RRI literature analysis
Stahl et al. (2017)	Purpose (motivation)	Motivation for doing research, Motivation for engaging with RI, Ethics (intended outcomes)	ICT industry with focus on health, and wellbeing
	Process (activities)	Anticipation, Engagement, Reflection, Governance, Ethics (research ethics), Responsiveness	
	Product (outcomes)	Gender / equality and diversity, Open access, social justice / inclusion, sustainability, Science education	
van de Poel et al. (2017)	Context (Environment and company)	Industry and market structure, uncertainties Resources, Dynamics, Stakes	High-tech sector (Nanotechnology, Synthetic Biology, Drones, IoT)
	Strategic level	CSR integration, RRI dimensions (Stilgoe et al., 2013), RRI as competitive advantage	
	Operational level	Stakeholder involvement, scenarios, trainings, ethicists, design for values	
	Outcomes	KPIs based on RRI dimensions and environmental and social sustainability values	
Fraaije and Flipse (2020)	Process qualifiers	Transparency, Inclusion, Reflexivity, Anticipation, Responsiveness	Broad RRI literature analysis
	Product qualifiers	Societal relevance, market competitiveness, scientific quality	
Gonzales-Gemio et al. (2020)	RI Enablers	Organizational flexibility, Shared collective vision, Internal and external drivers	Broad RRI/CSR literature analysis with SME focus
	RI Strategy	Anticipation, Inclusion, Responsiveness, Reflexiveness, Knowledge management	
	RI Performance	Environmental Sustainability, Social Sustainability, Diversity and Inclusion, Anticipation and reflection	

With the exception of the proposal of Stahl et al. (2017), all of the implementation frameworks analysed here attempt to describe what RI might look like in a company in its completed form. In doing so, they take different approaches and have different emphases, depending on their understanding of RI. This is an important element in helping to bring RI closer to companies. What often remains unaddressed in these models is the question of how a process of introducing and implementing RI in the firm should look like.

Stahl et al. (2017) have developed a maturity model in addition to their framework model (see Table 2), which represents a step-by-step approach to implementing RI in the company. This ranges from unawareness of RI to a stage where the company takes on a role model function by strategically pursuing RI.

A similar approach was taken by Pavie et al. (2014), which developed a five-step model to become a responsible and innovative organisation. These steps suggest to (1) "comply with the law", (2) "anticipate future legal requirements", (3) "think the value chain as an ecosystem", (4) "develop responsible products and services" and finally (5) "lead the change" (Pavie et al., 2014, pp. 68–78). At the same time, the principles of responsible and sustainable action should be the basis for all steps in the process. This model also shows the importance of a step-by-step development of a firm towards acting responsible.

Finally, Jarmai et al. (2019) suggested a very pragmatic approach that is worth mentioning, as it also provides a 5-step guide to how a firm can become more responsible in their innovation activities. They justify this very pragmatic approach with the typical questions of an entrepreneur as soon as he is interested in a new concept. These focus on concrete to-dos and the benefits that are connected with them for him/her and for the business. Thus, their five steps are to first "understand what responsible innovation is all about", to "reflect on the expected benefits of responsible innovation", to "establish management and employee commitment", to "develop and action plan for development/adaptation of practices and to finally "stay focused on the objective of responsible innovation" (Jarmai et al., 2019, pp. 11–12). This approach to an implementation model, which is more like a guide, is the most practice-oriented of the models presented here. At the same time it lacks a definition of RI in the firm, and at which levels it should be implemented in the firm. This is left up to the firm and the task is to work out a plan of what RI can look like in the respective company. Step one, however, requires an understanding of what RI is and how it can be applied in a business context. In this context, the previously presented implementation models can be useful.

In conclusion, the models presented here vary widely between very theoretical and very practical, but then with too little focus on the basic principles of RI. Therefore, there is a need for a trade-off between a theoretical implementation model and practical guidance for companies that does not dilute the basic principles of RI.

2.4.2. Implementation frameworks from RI related concepts for SMEs

Since the implementation frameworks analysed in the previous section are very general and only some of them are focused on SMEs, this section analyses some concepts for implementation in SMEs that come from the related concepts (see 2.3.2). They have been integrated into both academia and business practice for some time, so there is some documentation of their application in SMEs, yet there is no consensus on how CSR should look and be integrated into SMEs (Colovic et al., 2019).

Starting with CSR, the scientific community is also divided on how exactly CSR should be implemented in SMEs. However, there are already much more publications on this than on RI. There

is consensus though, that CSR implementation strategies of large companies cannot simply be transferred to SMEs (Fassin, 2008). It needs a specific approach that is adapted to the informal and entrepreneurial character of SMEs and the situation of limited resources.
Same as with RI, many SMEs already perform CSR activities without even being aware of the concept, nor that CSR is in any way formalised or strategically executed. This is due to an intuitive management style that is much more common in SMEs and the fact that the owner/manager often has multiple responsibilities. Formalised CSR strategies are rare in the EU, which is why researchers suggest to firstly assess the level of how much CSR is already being applied in the company and where there is still potential (Gelbmann, 2010).
In various studies on the use of CSR in SMEs, the picture was often consistent that CSR is integrated into daily management processes, but not formalised (in firms that perform CSR); only some SMEs have an informal CSR policy. The studies referred to were mainly regional and limited to one sector (Bevan & Yung, 2015; Castka et al., 2004; Colovic et al., 2019; Santos, 2011). Similar results from these studies show that CSR in SMEs is often internally focused and addressing goals such as an improved eco-efficiency in their supply chain, better social climate or good reputation in the local business and societal environment. Motivations for pursuing CSR include legal obligations, a better company image, giving back to the (local) community, fostering a better internal firm culture or "because it is the right thing to do" (Bevan & Yung, 2015, p. 303). However, due to different business contexts, the design of CSR strategies or policies in these cases has always been somewhat different, which makes the development of a general framework for CSR in SMEs challenging.
As SMEs have difficulties to deal with new concepts and strategies such as CSR, third party or intermediary organizations (such as the EU, NGOs or other Institutions) develop handbooks or guides to assess the status quo and give step-by step advice on how to implement and improve CSR activities (Gelbmann, 2010). They usually involve self-assessments and the integration of management and employees to develop a CSR strategy for the company and indicators to measure its success. As SMEs need tailored CSR concepts due to their character and specialisation in their business context, such a guide can help the firm to develop its own approach to CSR which is context specific (Colovic et al., 2019). In addition, many companies lack knowledge or other relevant resources to adopt CSR strategies that benefit e.g. the environment. Therefore companies need support through public or cooperative networks to acquire the relevant knowledge, that is often provided by external partners (Ortiz-Avram et al., 2018). SMEs' strength in maintaining internal and external networks, especially in their regional business environment, often makes it easy for them to use external sources of knowledge (Vanhaverbeke, 2017).

Similar to CSR, the implementation of Social Innovation or Sustainable Innovation in CSR is often not following formal structures or frameworks developed for large firms. Besides the reason that SMEs simply do not have the structures and resources for formalisation and institutionalisation, this is also because SMEs do not pursue these concepts for the sake of the concepts or the interest in them as such. Rather, the motivation is often to seize new business opportunities or to increase profitability. That is why it is not necessarily important for SMEs to implement a concept following formal criteria (Vanhaverbeke, 2017).
This also applies to the tools and techniques of Open Innovation and Frugal Innovation, which are used in the course of the innovation process and are not as deeply anchored in the corporate strategy as CSR. Therefore, no reference to implementation frameworks for these concepts in SMEs is made in this chapter.

In summary, it can be stated that the development of formal structures, strategies or implementation frameworks for almost all concepts is especially difficult for SMEs. This is due to limited resources on the one hand, but also to the high degree of specialisation of SMEs in their respective business context, which has a major impact on the implementation and alignment of strategies such as CSR, RI or Sustainable Innovation. Therefore, in the SME context, handbooks, guidelines or step-by-step tutorials have to be used to introduce new concepts, determine the status quo in the company and to (partially) integrate them into the management processes. In the case of CSR, certifications, or regulations such as ISO standards often serve as a basis for this.

2.5. Barriers and Drivers of RI implementation in SMEs

Due to the complexity of the concept and the far-reaching impact of its implementation on the entire company, there are of course also barriers to implementing RI in the company. This is basically since RI is widely unknown in the business sector, still being discussed in research and there is a lack of clarity as to how RI should be structured (van de Poel et al., 2017). In addition, only few vague implementation frameworks are developed, which are still very general and not directly applicable. These barriers affect both large companies and SMEs. However, SMEs have even greater barriers to implementing concepts such as RI due to their specific characteristics as described before. This chapter deals with the specific barriers of RI implementation in SMEs, but then also looks at the drivers that accelerate RI implementation or make it particularly attractive for SMEs (see Table 3 for a summary of the literature analysis).

Key barriers of RI implementation in SMEs

A first barrier to mention is that the RI concept is *partially divorced from reality in the business sector* (Auer & Jarmai, 2018). This refers especially to RI points of discussion, such as the democratic involvement of stakeholders or the general requirement, to only develop innovations that deal with the solution of the SDGs. Moreover, this very theory-based RI understanding makes the development of implementation frameworks, especially for SMEs, difficult (Gonzales-Gemio et al., 2020). SMEs cannot adopt such concepts on a large scale and must develop individual implementations of strategies based on guidance or manuals (see 2.4.2). Another major hurdle for SMEs is *the limited financial and human resources to deal with an initiative like RI*, especially when there is no governmental funding available for these processes (Auer & Jarmai, 2018). As described earlier, *SMEs lack governance structures which makes a formal integration of RI difficult*. Therefore, the integration of RI into SMEs is usually an informal process. To build up sufficient RI knowledge, as it is a complex concept, it requires strong personnel involvement of the company (Auer & Jarmai, 2018). In addition, the corporate culture must be open to this strategic change, otherwise a long-established culture can hinder this change process (Wittrock et al., 2021).

An additional financial hurdle can be the thought that innovation processes may become slower and more costly due to the integration of RI, which could ultimately lead to a competitive disadvantage (Yaghmaei, 2018). This slowing down could also happen through the democratic involvement of stakeholders, that raises multiple concerns and barriers at SMEs (RRing, 2020). A main point of criticism is *the protection of IP in processes of stakeholder involvement in a competitive environment*. It is often unclear how such a democratic process can be designed without creating IP problems, but at the same time anticipating all the consequences of innovation through stakeholder involvement

(RRing, 2020; Stahl et al., 2017). Another barrier to stakeholder involvement can be the difficulty of finding consensus for decision-making (Wittrock et al., 2021).
In some markets a major barrier for RI could be the *missing consumer/ customer awareness for sustainability or responsible products*, which makes creating a unique selling proposition and image based on RI difficult (RRing, 2020). This barrier could also come from company-side when SME managers see RI activities as too costly and without return in both short and long-term (Pavie et al., 2014). Lastly, the lack of cooperation with (regional) external partners and institutions can make it difficult to build up the missing knowledge that is needed for RI processes. At the same time, it can also be a barrier if supporting intermediary organisations are not present in the SME's environment (Arnaldi & Neresini, 2019).

Main benefits of implementing RI in SMEs leading to a competitive advantage
SMEs are partly *more driven by sustainability goals than by profit compared to large companies* (Halme & Korpela, 2014). This RI agenda can especially be driven when companies develop internal sustainability driven company cultures and formulate codes of conduct that drive employees to comply with RI (Auer & Jarmai, 2018). A basic prerequisite is that the SME manager is first generally open minded towards new concepts and ideas. But, according to Pavie et al. (2014) SMEs and its managers have characteristics that can lead to significant opportunities regarding RI adoption. They include the personal values and mindset of the owner/manager, the ability to react quickly to changing environments and less hierarchical structures.
RI implementation can also have *a positive effect on the general wellbeing of the employees and lead to higher loyalty and trust* (Pavie et al., 2014). But also externally*, the image and social acceptance of the company can improve* (Stahl et al., 2017). This is particularly important regarding the firm's customers and can lead to an increase in sales. In addition, in *some markets, customers can also be drivers of RI as they increasingly demand more sustainable and responsible products and firms* (Auer & Jarmai, 2018). Proactively offering responsible products would be a differentiator that can lead to a competitive advantage. But also legal requirements towards sustainability and responsibility (e.g., with regard to global supply chains) can drive the implementation of RI. SMEs that act *proactively towards stricter regulations and implement RI can anticipate these developments and gain a decisive (knowledge) advantage over their competitors* (Pavie et al., 2014).
To make RI more understandable and accessible to SMEs, there are many suggestions in the literature that could promote implementation and reduce barriers. These include more promotion and awareness of the RI concept with special focus on SMEs. There is also a need to develop more hands-on material to understand RI and recommendations on how RI can be implemented step-by-step in SMEs despite limited resources. These must enable the SMEs to independently assess a status-quo of RI practices in their firm. Many firms are already practising activities that can be attributed to RI but are carried out under a different label or intention (e.g., CSR). For this, the competitive advantages that can be developed through RI must also be researched and emphasised more.
In order to promote a broader implementation, governmental funding programmes can also help SMEs financially to develop RI strategies in pilot projects. There are already initial indications in the literature that public funding can increase the implementation of responsible business models in SMEs (Halme & Korpela, 2014).

Table 3. Overview of RI implementation drivers and barriers for SMEs

Context	Implementation Driver / Benefit	Implementation Barrier	Authors
Legal/ Regulations	Government promotion of RI with focus on SMEs	Theory driven recommendations and regulations divorced from reality	Auer and Jarmai (2018); Wittrock et al. (2021)
	Stricter regulations on sustainability, environmental friendliness and ethical supply chains requiring RI		
RI concept	Sources to understand the value of RI, self-assess the status quo and decide to rapidly adopt it	RI rather seen as add-on instead of central activity of the company	van de Poel et al. (2017); Stahl et al. (2017); Wittrock et al. (2021)
		General unpopularity of the concept in the business sector	
	Many aspects of RI already performed in company practices, just under different labelling (extension of CSR)	Theoretically driven concepts that remain unclear for many businesses, lack of implementation strategies	
Finance / Funding	Enhanced relationships with investors pursuing reduced risk investments	Insufficient or restricted access to existing subsidies and fiscal funding	Auer and Jarmai (2018); Pavie et al. (2014); Yaghmaei (2018); Halme and Korpela (2014)
	Public funding for RI implementation projects in SMEs	Higher Innovation costs expected from RI implementation leading to competitive disadvantage	
Company context	Improved corporate Image and social acceptance (integrity, loyalty, sustainability, innovativeness)	RI direction / definition unclear for stakeholders	Stahl et al. (2017); Auer and Jarmai (2018); Pavie et al. (2014); RRing (2020);(Schroeder, 2019)
	High relevance in industries/ sectors where innovation processes are highly regulated and align with RI	Transition and technical lock-ins (e.g., old technologies and infrastructure)	
External networks and collaboration	Innovation/Industry networks with intermediary organizations promoting RI	Lack of collaboration with (regional) research institutions, universities, or other intermediaries; Lack of supporting institutions	Arnaldi and Neresini (2019); Pavie et al. (2014)
	Enhanced relationship with institutions and local communities		
Market/ Customer orientation	Improved product-market fit and insights into customer needs leading to business opportunities	IP issues in stakeholder involvement processes	Pavie et al. (2014); Stahl et al. (2017); Auer and Jarmai (2018); RRing (2020); Wittrock et al. (2021)
	Consumer / Society pressure for sustainability / responsibility	Missing consumer awareness for responsible products	
	Improved relationships with suppliers/ customers and compliance with their rules	Increased customer / Stakeholder engagement can hamper finding consensus	
Management and organization	Improved alignment with the ethical values of the owner/ manager; general higher motivation of SMEs by sustainability instead of profits	Lack of governance structures in SMEs affects uptake of RI	Pavie et al. (2014); Auer and Jarmai (2018); Halme and Korpela (2014); Stahl et al. (2017); Wittrock et al. (2021)
	Internal culture or codes of conduct drive employees to comply with RI	Lack of RI knowledge requires strong staff involvement and knowledge management	
	Improved internal employee wellbeing and company culture	Long-established cultures prevent change to RI	
Company performance	Improved potential to attract new business, higher profits	Seeing RI activities as too costly and no return in the short- and long term	Arnaldi and Neresini (2019); Pavie et al. (2014); RRing (2020)
	Cost savings from eco-efficiency and proactive anticipation of issues in the innovation process	Slowing down of the innovation process by stakeholder involvement	

This higher adoption of RI in SMEs can also be achieved through a broad promotion of RI by institutions and regional economic development agencies that actively advise firms on developing their own RI strategy (Wittrock et al., 2021).
Coming to the elemental benefit of implemented RI, one major element is the *enhanced relationship to various stakeholders.* From a financial perspective, applied RI might make a company *more attractive to investors, as RI practices might reduce risks in innovation development* (Pavie et al., 2014). Through stakeholder involvement in the innovation process, *the relationship with suppliers and B2B customers can improve and the standards of RI usually also lead to compliance with the rules of the business partner* (Auer & Jarmai, 2018).
A better product-market fit and the discovery of (hidden) customer needs is one of the most mentioned benefits in RI literature. Market adoption risks can be minimised through intensive engagement with the opinions and needs of customers and other stakeholders (Stahl et al., 2017). This proactive anticipation of risks and problems in the innovation process can reduce costs and generate a higher profit. Additional cost saving possibilities come through increased eco-efficiency of the innovations (Pavie et al., 2014).
Finally, an important advantage of RI is the implementation in highly regulated industries/sectors such as the biotech or nanotechnology sector. As the innovation processes and government *approval procedures for new products demand high standards and values align closely with RI*, the implementation of RI can help to identify ethical or other obstacles early to adapt the innovation concept to anticipated problems at an early stage (Schroeder, 2019). In addition, in these sectors partly federal institutions are often the main customers, or are involved in these approval procedures, and *these must increasingly also give preference to responsibly developed products* (Stahl et al., 2017).

In conclusion, several barriers hinder the implementation of RI in the business practice of SMEs. These include that the RI concept is partially divorced from reality in the business sector, the limited financial and human resources of SMEs, the problematic of IP protection in processes of stakeholder involvement and the missing customer awareness regarding sustainable or responsible products in some markets. However, they are not impossible to overcome and are mainly due to the lack of clarity of the RI concept and the lack of practical business experience. If these barriers can be reduced and SMEs develop their own way of implementing RI in the organisation, a whole range of promising benefits can be developed based on RI: It can have a positive effect on the wellbeing, loyalty and trust of the employees and improve the company image and social acceptance towards the outside. In addition, it enhances the relationship with various stakeholders, including customers, suppliers and business partners and investors. Furthermore, the integration of stakeholders can lead to a better product-market fit and promote the discovery of (hidden) customer needs. Lastly, firms in highly regulated markets can benefit from proactive compliance with standards in approval procedures.
The research on the development of a competitive advantage on the basis of RI is just emerging, but the experience of related concepts, such as CSR and sustainable innovation shows that their strategic implementation is strongly linked to the development of a competitive advantage (Guerrero-Villegas et al., 2018; Porter & Mark, 2006).
However, before more detailed research on the development of a competitive advantage in SMEs based on RI can be conducted, specific recommendations for the implementation of RI in SMEs must first be identified. In the next section, a proposal for a conceptual framework for strategic RI implementation will be developed.

2.6. A strategic implementation framework for RI in SMEs

In developing a conceptual framework for strategic RI implementation in SMEs, the frameworks analysed in 2.4.1 are taken as the basis for the framework architecture and the RI dimensions and values. These are linked with the insights from the developed frameworks for SMEs for the related concepts as well as the general drivers and barriers for RI implementation in SMEs. In addition, the framework needs to be designed for strategic implementation, which includes the characteristics of strategy implementation, among other things a mission and vision. Secondly the RI strategies to be implemented need to be defined in policies or action plans that define which (competitive) advantage should be obtained by the implementation. And the third characteristic of strategic implementation is an iterative process, that frequently checks the results and reflects on the goals and if there is a need for changes in the strategic direction.

The focus was on developing a conceptual framework as a result that is universally applicable in SME business practice and as easy to understand as possible.

In the development of an RI implementation framework for SMEs, special focus is placed on several aspects. Firstly, it is important to integrate the basic ideas of RI into this framework, namely the dimensions anticipation, reflexivity, inclusion and responsiveness. In addition, a goal orientation towards solving the Grand Challenges (in this case UN SDGs) and the requirement of ethically acceptable, sustainable and societally desirable innovation outcomes must be included. This is a basic prerequisite in order not to dilute the concept of RI and achieve only a form of CSR or sustainable development as a result.

Secondly, the specificities of SMEs in terms of general adoption of new concepts and the barriers specific to RI need to be considered. They include the lack of resources and (governance) structures. To overcome the barriers of unclarity of the RI concept, a requirement for the framework development is also the ease to understand and implement it in SME settings.

What almost all analysed barriers for SMEs towards RI have in common are hurdles towards the process of generally integrating new concepts and not necessarily towards the RI concept in general (except for the lack of clarity of the RI concept, which however does not only affect SMEs but also large firms or other institutions). Therefore, special emphasis is also placed on the strategy formulation, which is included as a central element of the strategic implementation framework.

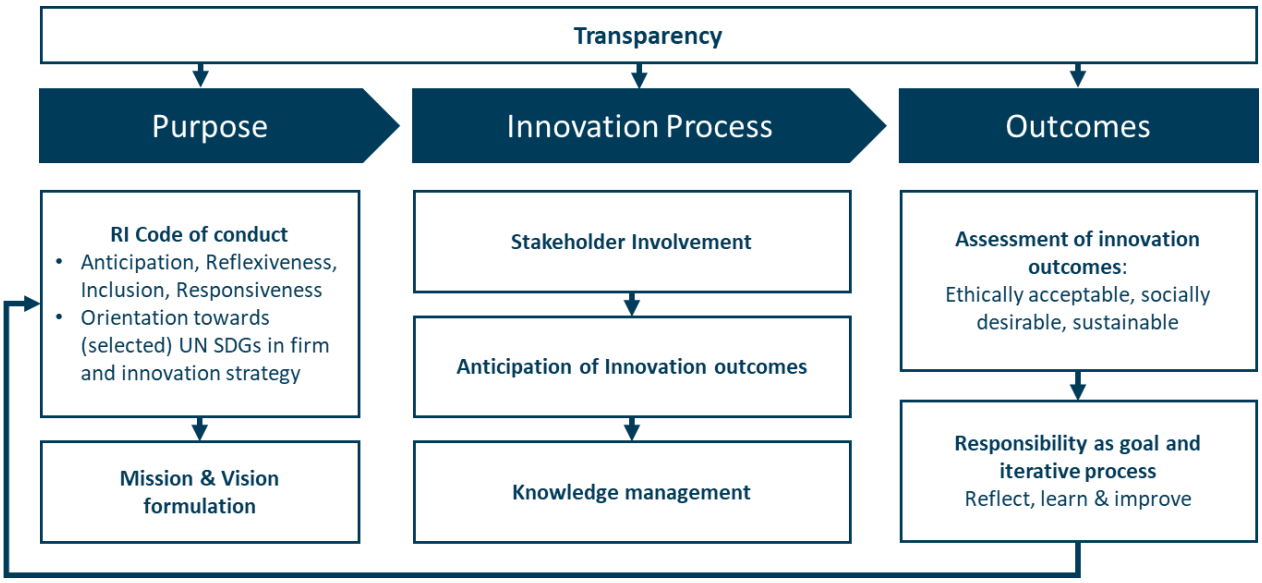

Fig. 7. The conceptual framework of strategic RI implementation in SMEs

The proposed conceptual strategic implementation framework for RI in SMEs is based on the structure developed by Stahl et al. (2017) for their maturity model, dividing the RI components in the categories of purpose (motivation), innovation process (activities undertaken) and product (outcomes). It is intended to highlight the breadth in which RI needs to be integrated in the company, even though it may not be formally institutionalised in the case of SMEs.

Purpose

The first element of the framework is the *purpose*, representing the strategic level of the firm.
In SMEs, the firm strategy is not always clearly formulated. Therefore, to achieve a strategic implementation of RI, the purpose element of the framework is divided into two components.
The first essential element of this strategic implementation, which was identified in the literature review and found to be suitable for the SME context, is a firm policy defined in a code of conduct for RI. The code of conduct lays the foundations for the ethical values and responsible behaviour of the company, which are the basis for all decisions of the firm through their integration into the company strategy. At the same time, the code of conduct also contains an orientation towards (selected) SDGs on which the company wants to focus and make a societal contribution to their solution (see Table 4). This RI code of conduct is an outcome of a formulation process which is elaborated in the following and should be integrated in the firm's vision and mission statement to implement it in the whole firm.

The RI code of conduct should be the result of a process of organisational engagement. An example is shown in Table 4 and will now be briefly explained. As a starting point it is important that the manager/owner of the company gets to deal intensively with the concept of RI. This is also a barrier, as described before, because the manager is often already busy and has many responsibilities at the same time, but in SMEs the manager is usually the decision-maker and the company is based on his/her values (Pavie et al., 2014). Therefore, the understanding of the pillars of the RI concept is a necessity. The implementation of RI in SMEs can only be successful if the manager understands the concept and if it is aligned with his/ her personal values and motivation (Jarmai et al., 2019). Publications such as those of the KARIM project can be helpful in this respect (Hin et al., 2015), additional sources include the COMPASS project or the RRI Tools website which incorporate many RI publications and tools related to practical applications (COMPASS, 2019; RRI Tools, 2021).
Once the basics of the RI concept are understood, it makes sense to use a self-assessment tool to get a quick overview of which processes in the company may already be in line with the RI values and in which areas of the company there is the greatest need to catch up. Some tools are provided on the aforementioned project websites RRI Tools and COMPASS. These tools still have potential for improvement, but are a good base to help understand the extent to which the RI concept is interwoven into all areas of the company and its processes (Stahl et al., 2017). Before the manager can then decide for or against an implementation process, a look must also be taken at the economic, social and technological industry drivers and whether trends and the current situation in which the company finds itself speak more in favour of or against RI. Without question, the implementation of the RI concept in the company initially means a higher resource requirement, which does not necessarily pay off in the shortest time.
The next step is organizational involvement of how RI can be implemented in the company. As SMEs often do not have formalised (governance) structures, the approach taken in this framework is to bring RI values closer to every employee and anchor them in the company culture. As described by Barrick et al. (2015), organizational involvement in the strategy process can help to both deal with limited

resources and to align the strategy closer with the actual firm culture. This can result in a higher motivation in the workforce and a more successful strategy implementation.
This should start with internal processes or workshops where first also the employees learn about the RI concept in general and which benefits it can bring to a company (Jarmai et al., 2019). It is essential that this process is democratic and transparent to overcome internal culture barriers. Therefore, the development process itself should already reflect the RI values of reflection, anticipation, inclusion and responsiveness. Depending on the size of the company, it makes sense to involve all employees in this process. If the company is too large, working groups should be formed that represent a cross-section of the workforce.
The aim of this phase is to conduct a more comprehensive analysis of the company context than conducted in the first phase. For this purpose, industry trends, drivers, uncertainties and other context-specific factors must be included in the analysis in order to show all employees the possible benefits, but also the barriers of RI. The use of scenario techniques, case studies and the involvement of (industry) experts and other relevant stakeholders can help here.
Another important component of this phase is the examination of the grand challenges, preferably the UN SDGs as they are more widespread. Based on the SDGs, possible points of overlap with the company's products, processes and values need to be identified. The goals where the company has the most influence (even if only indirectly and marginally) should be selected.
This phase of the strategy development process is certainly time-consuming and resource-intensive, but it is necessary to gain the commitment of the employees towards RI. A motivated and charismatic manager can play a major role here and must reflect the commitment to this strategic process by investing these (time and personnel) resources.
As a result of this analysis process, an RI *code of conduct* should be agreed upon. This code of conduct is suggested to be the cornerstone of the company's RI strategy and their actions and drive the RI agenda forward. A code of conduct can drive RI in an SME without having to create governance structures that take up additional resources that may not exist (Auer & Jarmai, 2018). For that reason, it must be formulated in a simple and understandable way to anchor itself in the minds of the employees and the company culture. The code of conduct must be internally and externally transparent and be communicated well.
The core values of RI should be reflected and ensured in the content of such a code of conduct. These minimum requirements have been compiled based on the analysis of RI implementation frameworks (see 2.4.1) and can be found in the following Table 4.

Table 4. Requirements for RI code of conduct implemented in SMEs

Dimension	Elements of the code of conduct
Purpose	Orientation towards (selected) SDGs that fit to the company's business context.
	Ethical acceptable, socially desirable and sustainable innovation processes and innovation outcomes.
(Innovation) Process	Anticipation of potential innovation outcomes.
	Reflection on others' opinion and situation.
	Diversity & Inclusion (stakeholder involvement) in company processes, products, communication, and relationships.
Outcome	Commitment to learning and knowledge management towards achievement of RI success.

In addition to the core values of RI, based on the core dimensions and an orientation towards solving the SDGs, the commitment to learning and knowledge management was included in the code of conduct. This is particularly important for SMEs, as RI can require new competences (e.g. for new levels of environmental friendliness), but these competences cannot always be recruited in SMEs due to limited resources. Therefore, this missing knowledge must be developed either by the employees themselves or through cooperation with partners.

As in the development process, the results should be reflected on with the involvement of stakeholders. This code of conduct can then serve as a basis for the implementation of RI in the firm. The contents of the code of conduct should be regularly reviewed, questioned and complemented. Subsequently, the RI Code of Conduct should be integrated into the corporate mission and vision in order to create a strategic basis for implementation and goals to be achieved.

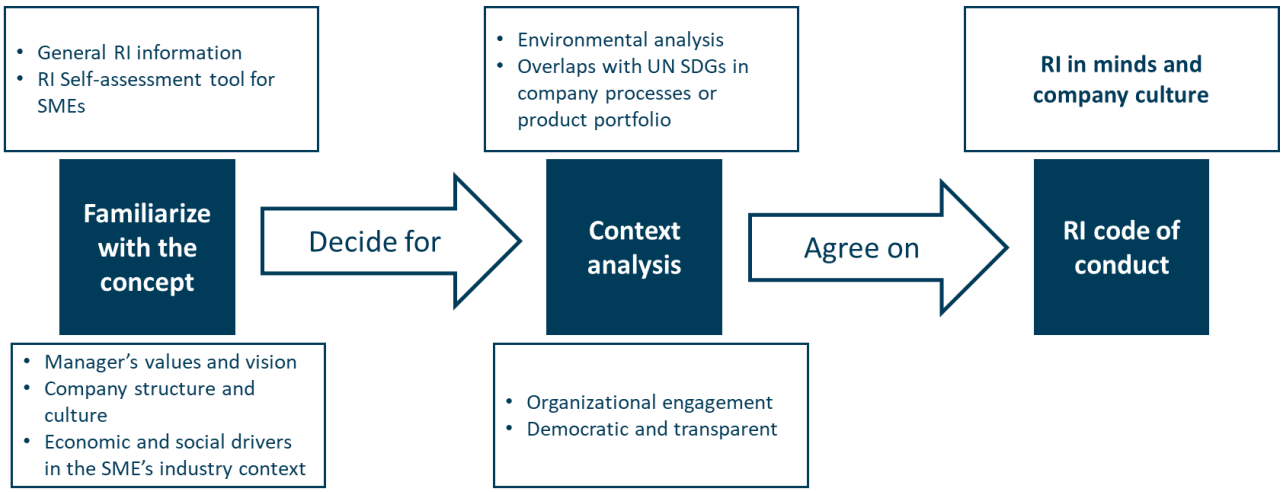

Fig. 8. Exemplary formulation process for a RI Code of Conduct

Process

This *process* element in the framework is intended to represent the daily activities of the firm and its processes, with a particular focus on the innovation / new product development process. Due to the high degree of specialisation of SMEs, the requirements for RI structures in the operational area of the company are so individual that it is difficult to map them in a general framework. Therefore, the RI code of conduct also forms the basis for the firm's operational activities and especially the innovation process. In addition, there are three essential elements of RI that are suggested to be anchored in the firm's innovation process.

The first is the inclusion of stakeholders in all stages of the innovation process. As SMEs often do not have such a high visibility and a limited network, engaging stakeholders from different interest groups can be difficult. In addition, broad stakeholder engagement is often not feasible for SMEs from a resource perspective. Therefore, as a compromise, it is suggested that targeted opinions are gathered from different groups of people and that critics are also integrated. To identify potentials for innovation development, the integration of users can positively influence the success of the innovation process.

Secondly, the anticipation of consequences and influences of the developed innovations is a crucial element of RI in the firm. Since this cannot always be done by means of a broad analysis and stakeholder involvement should serve as a basis to gather information. Scenario techniques can be applied to further map potential innovation outcomes. Possible negative outcomes of the innovation

processes should be assessed according to the criteria of the RI code of conduct and, if necessary, the innovation project should be adapted or rejected.
Thirdly, knowledge management was identified as another important component of strategic RI implementation in SMEs to solve more complex (technological) problems in the innovation process despite limited resources. This can be the case, for example, with higher levels of environmental friendliness. Here it is important that employees are committed to learn and close knowledge gaps within the company, e.g., with the involvement of external stakeholders.
Other concepts, tools and techniques that can be applied in the RI process to increase success and achieve better RI results are very context specific and depend on the firm's industry. Examples can be found in various academic papers. Here, the publications of Stilgoe et al. (2013), Lubberink et al. (2017) and van de Poel et al. (2017) are to be highlighted.

Outcomes
Finally, the *outcomes* of this RI process should be assessed based on the criteria agreed on in the code of conduct. The main criteria are social desirability, ethical acceptability and sustainability. Achieving all criteria according to the RI concept is difficult and should therefore be an iterative process of learning and improving. Reflection on the RI process and outcomes and whether the code of conduct has been sufficiently and appropriately formulated need to be discussed. Assessment of results and iterating on the RI strategy is an essential component of strategic implementation. Measuring RI outcomes using fixed KPIs can be an option but does not necessarily have to be carried out in SMEs for resource reasons.

Transparency
Assessment of RI outcomes often is connected to transparency in the literature. It is recommended to publish RI results in reports, similar to CSR. Since this would require enormous additional resources and many SMEs do not have such high visibility anyway, it is not integrated in this framework. What is important, though is the transparency of the company's RI values and activities to the public to give insight for partners and stakeholders. However, targeted and public RI reporting can make sense if the industry is highly regulated and values are strongly aligned with RI. This passive transparency is not only relevant for innovation outcomes but applies to all phases of the model presented here: purpose, process and outcomes.

In conclusion, this conceptual framework for strategic implementation of RI in SMEs consists of three major elements: Strategic purpose containing the RI code of conduct integrated in the company vision and mission, the innovation process with the activities of stakeholder involvement, the anticipation of innovation outcomes and knowledge management and finally, the assessment of innovation outcomes and reflection and iteration of the RI process. All elements are characterised by transparency to the outside of the firm. The RI code of conduct plays a central role in overcoming the barriers that SMEs typically face in strategically implementing new concepts, such as the limited resources, missing governance structures and lacking commitment of the employees. It may help to develop an individual approach of RI for the respective firm and thus, as described before by the maturity model of Stahl et al. (2017), to achieve more responsible company action and outcomes step-by-step.
A framework cannot solve all difficulties at the same time, but it can make a significant contribution to making RI more accessible to SMEs. The applicability of this proposed framework is explored in the following chapter.

3. Research Methodology for the analysis of strategic implementation of RI in SMEs

3.1. Research design

RI is a rather complex concept that became visible around 2010 and gained popularity with the definition of Schomberg (2012) and the engagement of the EU. The discussions in the literature today are still predominantly dealing with the definition and understanding of the RI concept, which shows that there is a lack of empirical research. Research into implementing RI in firms is lacking empirical studies, as implementation models are vague and little tested, as described in the previous chapters. This is particularly relevant for SMEs, which, due to their special characteristics and limited resources, cannot implement the concepts usually developed for large companies.
To contribute to this lack of research on RI implementation in SMEs, the key dimensions and implementation frameworks of RI were already analysed in a literature review in the previous parts (see Table 2), conducting a comparative analysis. The same applies to SME specific literature on related concepts (see 2.4.2), RI implementation drivers and barriers (see Table 3) and general definitions of strategy implementation (see 2.1) and innovation management in a company (see 2.2). Based on the necessary requirements and elements for a strategic implementation framework for RI in SMEs, identified by the literature review and the comparative analyses, the conceptual framework was developed and explained (see 2.6).

To test the framework and validate its elements, a *qualitative research approach* is most suitable to achieve the research objectives and was applied in the empirical study. Qualitative research builds on "assumptions and the use of theoretical frameworks that inform the study of research problems addressing the meaning individuals or groups to a social or human problem" (Creswell & Poth, 2018, p. 35). A main characteristic of qualitative research is the collection of data in a natural setting sensitive to the human or organization that is studied (Creswell & Poth, 2018). According to Welch et al. (2013) a qualitative case study approach can be suitable for both theory building and testing, which makes this approach suitable for the intended research aim. The choice of the qualitative research approach is grounded on the broad unawareness of RI in the business sector, which makes theory building or validation via quantitative analyses difficult. This is one reason for the general lack of quantitative research on RI implementation in the business context (Čeičytė, 2019).
The *deductive logic* of this thesis builds on developing a theory based on the literature review and its comparative analysis and validating the theory by qualitative data collection and analysis using *the case study method* in a second step (see Fig. 9). The focus was on assessing the strategic RI implementation in the particular case and to validate the single elements of the proposed conceptual framework for its applicability in the given context. Many businesses already perform activities that align with the RI elements, however, are not aware that those are part of RI due to the unfamiliarity with the concept (van de Poel et al., 2017). Therefore, the strategic RI implementation in the company must be recorded, which requires either the complex use of a self-assessment tool or specific questions from a person who is familiar with the RI concept and can be sensitive to the given context. In addition, there is a general lack of RI implementation theory in the SME context, which gives a case study method the reasoning for application in the context of the research aim of the thesis as case studies "have a naturalistic approach and are sensitive to the complexities and interactions in a particular context" (Creswell & Poth, 2018, p. 414). The choice of biotechnology firms as research context and the design of the qualitative case study are elaborated in the following chapters.

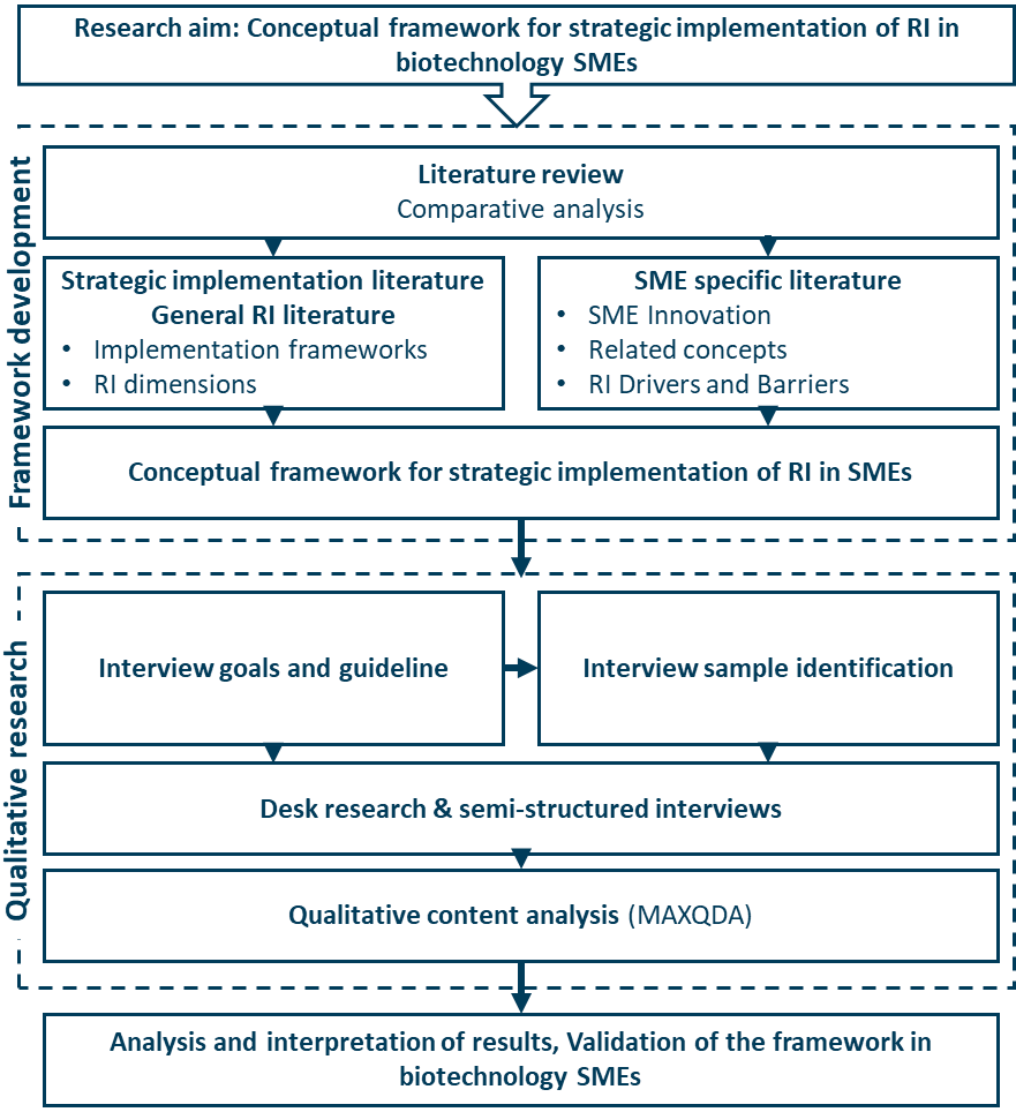

Fig. 9. Qualitative research design of the thesis

The case study methodology was applied to gather detailed information of the case firms via secondary data analysis and semi-structured interviews. The secondary data about the case firms was gathered to ensure triangulation (Yin, 2003). The data was collected by desk research before the respective interview, to be able to ask more specific questions and follow-up questions. Sources of the data were the firms' websites, press releases, (financial) and company databases.

Semi-structured interview were conducted to reveal current firm practices and personal values by asking prepared questions and follow-up questions or clarifications, which is especially important due to the complexity of RI and its practices, which can be found in a wide range of corporate activities (Brinkmann & Kvale, 2018). The interview guideline is based on the elements of the implementation framework that were extracted in the literature review and the research objectives. As the research was conducted in Germany, the interview guideline was prepared in German and English language (see Appendices 1 and 2). The interviews were prepared following the suggestions by Brinkmann and Kvale (2018) and Bogner et al. (2014). To ensure a high quality of the case study research, the evaluation criteria for case study research in innovation management context by Goffin et al. (2019) are followed in conducting the study. Therefore, a pilot interview was conducted before the first interview to check the suitability of the interview guideline, timing and to correct unclear phrases.

3.2. Case selection

To validate the strategic implementation framework for RI in SMEs, a specific industry and geographical context were selected. This is due to the suggestions in the literature that adaptions of RI in the industry are dependent to local characteristics and industry context (Gurzawska et al., 2017; Ladikas et al., 2019). This implies that the potential validation of the proposed framework is limited to the selected research context.

Research on RI implementation in SMEs is not very well developed yet. To select an industry for the research context, the rationale was considered in which industry RI implementation can be of particular benefit to SMEs. RI can create advantages especially in highly regulated industries where the regulations of the innovation process are strongly aligned with the values of RI (Stahl et al., 2017). Here, the implementation of RI and proactive compliance with the regulations can bring particular advantages for the firm. In research-intensive biotechnology firms, technology assessment was already a frequently applied concept, and initial studies show that the application of the much more far-reaching concept of RI can be fruitful here (Stemerding, 2019). While at the same time RI is seen as having great relevance for the biotechnology sector of the future, the lack of awareness of the concept and the lack of concrete implementation examples is also a problem here (Rosemann & Molyneux-Hodgson, 2020). In addition, several of the Grand Challenges or UN SDGs are aligned with innovations that need to be developed by the biotechnology sector. Therefore, the biotechnology sector is selected as the research context for the qualitative case study.

As of geographical limitation, Germany was selected due to the familiarity of the author with the market and the ease of conducting case study interviews in native language without important content-related insights being lost or not recognised caused by language barriers. The concept of RI is neither a functional term nor well-known in Germany (Ladikas et al., 2019). But RI values and practices, especially regarding ecological sustainability or gender equality, are well known in business practice and society. In some cases, these values are even legislated, e.g., by regulations on emissions, on accessibility or equal participation in leadership positions in public services and private firms. It is therefore particularly important to assess the status quo of RI in the company within the scope of the study and to distinguish between voluntary RI activities and those required by law.

The context of biotechnology SMEs in Germany was selected for the qualitative case study. Biotechnology is defined by the OECD using a broad single definition and a list-based definition, including activities that might not be covered by the single definition. According to the single definition, biotechnology is "the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services" (OECD, 2013, p. 156). Additionally firms are defined as biotechnology when they report at least one of these activities: "DNA/RNA; proteins and other molecules; cell and tissue culture and engineering; process biotechnology techniques; gene and RNA vectors; bioinformatics; and, nanobiotechnology" (OECD, 2013, p. 156).

With 710 dedicated biotechnology firms, according to the definition above, Germany ranks first in terms of the number of biotechnology firms in the EU (Ernst & Young, 2021). Of these, 23 companies are publicly listed. The 687 privately owned biotechnology firms employed approximately 23,400 people in Germany in 2020 (Ernst & Young, 2021). This study focuses on the SME firms in this sector.

Sample companies were identified by using databases of biotechnology clusters and associations as well as targeted LinkedIn search. Using publicly available data from the firms' websites and firm data extracted from LexisNexis, the suitability as case company was *selected purposefully* by *predefined criteria* (Creswell & Poth, 2018; Patton, 2015):

1. Firm is a biotechnology company by OECD definition (use of NACE code);
2. Firm is an SME by EU definition (use of LexisNexis employee and financial data);
3. Firm actively develops innovative products or services;
4. Firm works on solutions that can be related to the UN SDGs;
5. Firm engages in collaboration projects or practices of stakeholder engagement;
6. Firm headquarter is in Germany, R&D and majority of employees are in Germany.

Firms that claim to act responsible or focus on sustainability and firms that do not specifically communicate responsible activities were both taken into consideration to have potentially either of the cases in the validation study.

3.3. Data collection and analysis

Based on these predefined criteria presented above, 48 biotechnology SMEs were identified and contacted via phone, email or LinkedIn to request an interview. In order to increase the willingness to participate, a rough summary of the questions was provided in advance and privacy was assured through anonymisation of the cases (Brinkmann & Kvale, 2018). In addition, the learnings of Flick et al. (2019) in engaging SMEs in RI research were taken into consideration during interview planning and acquisition, such as the use of adapted terminology in the light of unawareness of the RI concept. Due to the COVID-19 pandemic, 9 biotechnology firms were actively developing solutions to tackle the pandemic and were, according to their feedback, currently unavailable for interviews.

In total five interviews with representatives of five different companies were conducted (see Table 5). The interviews were done with the CEO or with the head of R&D, as they have an overview of both the corporate strategy and innovation activities. The interviewed firms are from different areas of biotechnology and vary in SME size (according to the EU definition) from micro to medium (see Table 5). The basics of the RI concept were explained at the beginning of the interview. Due to the pandemic, all interviews were conducted and recorded via videocall upon the agreement with the interviewees. One interview was conducted in English, the others in German. The interviews were conducted between 20 April and 6 May 2021. The length of the interviews varied between 25 and 46 minutes.

The interviews were transcribed, anonymised and together with the secondary data gathered in the desk research transferred to the software *MAXQDA 2020 Plus* for a qualitative content analysis (Rädiker & Kuckartz, 2019). The data, in form of text, was processed by a coding system, ordered according to the elements of the framework to validate them, and extracted. The extracted text refers to the passages of text that are relevant for the investigation and validation of the framework elements and is provided as a quote, together with the relevant codes (Gläser & Laudel, 2010). Relevant quotes from the interviews were translated from German into English.

During the study, *ethical values* were ensured through voluntary participation of the persons in the interviews. In addition, all questions were clarified before the interviews and the anonymity and data protection of the participating persons and companies was preserved. At the request of the interviewees, transcripts were sent to the participants for review after the interviews.

4. Research findings on strategic implementation of RI in Biotechnology SMEs and discussion

4.1. Overview of case firms

In the following, the areas of activity of the case firms examined are briefly described, without going into detail and disclosing the anonymity of the companies involved. In addition to the main areas of activity, further details, such as the official industry code, year of establishment and size classification according to the SME categories of the EU, can be found in Table 5.

Table 5. Overview of case firms

Case firm	NACE-Code	Size[2]	Founded	Interviewee position in the firm	Interview duration
A	20140 - Manufacture of other organic basic chemicals	Small	1991	CEO/Founder	25 mins
B	72110 - Research and experimental development on biotechnology; 21200 - Manufacture of pharmaceutical preparations	Medium	2003	Head of R&D	46 mins
C	72110 - Research and experimental development on biotechnology	Micro	2019	CEO/Founder	41 mins
D	72110 - Research and experimental development on biotechnology; 72190 - Other research and experimental development on natural sciences and engineering	Small	1998	CEO/Founder	43 mins
E	72100 - Research and experimental development on natural sciences and engineering	Small	2001	CEO/Founder	45 mins

Case firm A is a small SME that develops and sells enzymes, microbial mixed cultures and other biotechnological products, that are partially engineered genetically. Besides special developments for customers, the company is involved in funded research projects of the EU and the German Federal Ministry of Education and Research in its area of expertise. The interview was conducted with the CEO.

Case firm B is a medium SME that is VC-backed and active in industrial enzyme engineering and process development for highly regulated markets such as the food or pharmaceutical industry. Due to its size, the product portfolio is more diversified than the other firms studied. Since the VC funding, the firm has grown strongly and continues to plan for strong growth. The firm is also involved in publicly funded projects, but this only refers to a small amount of the development projects. The interview was conducted with the Head of R&D.

Case firm C is a young, seed-funded university spin-off that develops sustainable polymers for a wide range of applications. The application focus of their patented technology lies on the cosmetics and food industry, as well as on sustainable materials in the textile industry. The interview was conducted with the CEO.

Case firm D has a two-part product portfolio in which innovative processes and products are developed and marketed. On the one side, the firm develops plants with new properties and innovative

[2] Size categorisation according to the EU definition of SMEs, based on the headcount of staff, annual turnover (if data available) or the annual balance sheet total, European Commission (2020b).

farming methods through non-genetic engineering methods. On the other side, the firm focuses on industrial biotechnology and the production of genetically modified products and the synthesis of other high-quality biobased products.
Case firm E specialises in marine biotechnology and develops cosmetic products, products based on maritime raw materials and active ingredients for the food industry, as well as substances for medical products and pharmaceuticals. The interview was conducted with the CEO.

4.2. Case analysis of strategic RI implementation

4.2.1. Case firm A

Case firm A develops biotechnical processes of all kinds using enzymes for the application areas of food technology, environmental technology and pharmaceutical products since 1991. This is also reflected in the firm's mission statement, which further defines that these solutions should be "organic, eco-friendly and cost-effective solutions to environmental, food and biotechnology problems" (Case A_Doc5)[3], which also includes an aspect of ecological sustainability. A corporate vision could not be mentioned, which may show a lack of strategic orientation.
Two-thirds of the firm's innovation development projects take place as part of publicly funded projects with partners.
The interviewee was not familiar with the RI concept. However, it was stated that the products developed by the company "are all sustainable and have no negative impact on climate change" (Case A_Interview, Pos. 16). Regarding his or her motivation to develop innovations, the answer was towards "working to secure jobs" (Case A_Interview, Pos. 10) by developing products that can be sold. This indicates more a customer orientation in innovation development than an orientation towards e.g., UN SDGs in the innovation strategy. However, it also shows a social responsibility towards the employees. Although sustainability may not be a top priority, the enzymes developed by the company are used for environmental sustainability purposes. This is also evident in an exemplary funded research project, in which the company participated, involving biorefineries based on the circular economy model, a concept consistent with RI's sustainability values (Case A_Doc4).
Looking at the *purpose* element of the proposed conceptual framework, which reflects the strategic component of RI implementation, the firm is technically oriented towards sustainability solutions, but did not strategically implement responsible values in their mission and lacks a vision.
Regarding the *process* element of the conceptual framework, the company primarily practices *stakeholder involvement* by engaging "Universities, research institutes, public institutes, Fraunhofer institutes, but also companies" (Case A_Interview, Pos. 26) that are customers in the R&D processes. Most of these projects are publicly subsidized and each partner has its specific tasks. The aim of such research cooperation from the point of view of the firm is knowledge exchange by „providing each other with information" (Case A_Interview, Pos. 36). In addition, the funded projects always involve partners whose task it is to evaluate the sustainability of the technology being developed. These are then "responsible for life cycle assessments" (Case A_Interview, Pos. 48) and for "revealing which aspects are not sustainable" (Case A_Interview, Pos. 54). These assessments are performed due to regulatory necessities and not proactively conducted by the firm.
Regarding the *anticipation* of possible negative innovation outcomes, the firm is not taking measures.

[3] References of quotes in the content analysis indicate the document source and position in MAXQDA.

Knowledge management is seen as a core competence of the firm since knowledge or competence gaps must be closed in almost all development projects. This happens either internally "through experiments [...] and of course literature research" (Case A_Interview, Pos. 34) or "through know-how of the partners in collaborative projects" (Case A_Interview, Pos. 34).
Looking at the *outcome* element of the conceptual framework, the firm *assesses their innovation outcomes* primarily by using criteria of environmental sustainability, predominantly through life cycle assessments. However, this is only done in funded projects. „We ourselves do not make life cycle assessments for our products" (Case A_Interview, Pos. 22) the interviewee says regarding the development projects carried out under the firm's own direction. They only "assess which process is more sustainable" but "without following formal criteria" (Case A_Interview, Pos. 24).
In addition to the environmental criteria, however, regulatory requirements demand statements on ethical criteria. This is particularly the case "for projects involving genetically modified material and for pharmaceutical products" (Case A_Interview, Pos. 44) involving animal testing, which are carried out by project partners. The case firm does not conduct any animal testing itself.
In funded projects, the sustainability requirements that must be met are often so high that no result can be achieved after the end of the funded project, which is also economical. This leads to the situation that "more than 50% [of the projects] do not proceed due to lack of profitability or lack of sustainability" (Case A_Interview, Pos. 55).
Regarding the element of an *iterative process* the interviewee did not mention any iterative elements that are related to the innovation process, outcomes or strategy development, other than the resume that "have to be drawn by regulation in publicly funded projects" (Case A_Interview, Pos. 38).
For the last element of *transparency* of the firm regarding its innovation processes and values, the interviewee has referred to the research reports and "scientific publications [that] are published in publicly funded projects" (Case A_Interview, Pos. 50). However, in these projects there are also "confidential areas that are not available for public access" (Case A_Interview, Pos. 50).
In summary, case firm A is developing innovative solutions, that are used to solve sustainability problems reflected in the UN SDGs. However, these RI values are not formally integrated into the strategy. Regarding the innovation process and outcomes elements of the conceptual framework, the firm complies with the high standards that apply in the industry in Germany, but does not go beyond them in terms of the assessment of innovation outcomes or transparency of the innovation process. Due to the lack of RI values integrated in some sort of firm policy, ambitions to achieve competitive advantages by higher sustainability and responsibility standards and a missing procedure to reflect and iterate on innovation outcomes, strategic elements of RI implementation, could not be identified in this case. A benefit the firm obtains by operating at certain sustainable and ethical standards is that this is a prerequisite for the allocation of public funding through research projects – which the firm depends on to operate economically.
One reason for the lack of further responsibility activities can be the economic situation of the firm, as the interviewee stated that they often have bigger problems than sustainability. "That we have products that can be economical at all. If the products cannot be economical, then we do not need to worry about sustainability" (Case A_Interview, Pos. 52).

4.2.2. Case firm B

Case firm B is a medium-sized enterprise focused on industrial enzyme engineering and process development for highly regulated markets, such as the food or pharmaceutical industry. It was founded in 2003 and is backed by several rounds of VC funding, whereas the last financing round

was a Series-C round. The company has ambitious growth plans that are justified by a broad innovation pipeline. Core competence is industrial process development, where the firm's technology enables it to carry out biotechnical processes in a particularly resource-conserving and energy-efficient manner, which also gives them a cost leadership in their field. Other developed or planned innovations include fermentative products for bioplastics, enzymes for the food industry and ingredients for the pharmaceutical industry. During the COVID-19 pandemic, the firm has also added key substances that are needed in the production of vector vaccines to its portfolio.
Because of the size of the company (>160 employees) and its growth plans, it has developed clear organizational structures and business units. The interviewee was the Head of R&D and not familiar with the RI concept.
Applying the *purpose* element of the conceptual framework, the firm's innovation activities are focussing on environmental sustainability, food and well-being are aligned with UN SDGs, although this connection is not explicitly made in the firm's mission or vision or some sort of sustainability agenda. The firms vision focusses on "becoming a global leader in tomorrow's biotechnology sector" (Case B_Interview, Pos. 17). The interviewee ensured that, although these values are not specifically integrated into the mission and vision, sustainability values were a top priority although "conditional upon an economic success that is superior to it" (Case B_ Interview, Pos. 9). The firm wants "as a general rule, produce CO2-neutral. Of course, this is not always or not yet always possible, but this is our goal" (Case B_Interview, Pos. 33). Next to innovation processes, the firm also pursues projects to reduce the ecological footprint of the firm by "reducing plastic waste and finding solutions for the further use of the unavoidable laboratory waste from plastic" (Case B_Doc4). This shows that the firm is ambitious to achieve its sustainability goals. In addition, the firm supports the bioeconomy strategy of the Federal Ministry of Education and Research and receives public funding through this program, which is promoting a transformation of the German economy towards a circular economy.
Regarding the strategy development process of the firm, "in the past, the whole team was involved. Now, of course, we have grown considerably, and we have built up two strong management levels. Here, the strategy processes now mainly take place, but of course the opinions of the employees are always reflected and included" (Case B_Interview, Pos. 19). This shows that the strategy processes in the company are well structured and that employee involvement in the strategy process is also an important component. Even if the firm's sustainability goals are not embedded in the vision and mission, they seem to be very present in the overall strategy and important component in achieving building their competitive advantages for the firm.
Looking at the *stakeholder involvement* aspect of the *process* element of the conceptual framework, the firm states that "cooperation is a key business element" (Case B_Doc1) and strongly relies on strategic alliances in sales and technology development. In addition, "we work closely with our customers in all phases of the innovation process" (Case B_ Interview, Pos. 21). Also, there are research collaborations with universities and research institutes, particularly in the case of funded projects. In selecting cooperation partners, the company always looks for "expertise or [...] competencies" (Case B_Interview, Pos. 23).
Regarding the *anticipation* of innovation outcomes, the firm claims to operate "according to the general principles of research and pay attention to ethical and environmental protection aspects" and "consider the possible negative consequences that may occur and also assess the risks here" (Case B_Interview, Pos. 27). The interviewee emphasizes that "with regard to potentials and risks, they also have [their] advisory board, in which [they] have various experts from business and science who can also make targeted assessments with their expertise" (Case B_Interview, Pos. 29).

The element of knowledge management was described, as in the previous case, as “in the nature of the company” (Case B_Interview, Pos. 31). Knowledge gaps are closed either by the competencies of “external cooperation partners” or internally by “the different competencies of the employees” (Case B_Interview, Pos. 31). For some projects, “new employees [...] are hired specifically” (Case B_Interview, Pos. 31).

For the *assessment of innovation outcomes,* the firm considers “ethical and environmental aspects” (Case B_Interview, Pos. 27) and often engages external service providers to carry out an independent assessment of sustainability, e.g., by conducting “life cycle assessments” (Case B_Interview, Pos. 27). These assessments are conducted for all products and processes developed and not only where it is required by regulations. Plus, the products developed for the pharmaceutical and food industries require authorization, which includes reports with, among other things, ethical and sustainability criteria. Here the firm is also involved in the development of industry standards of enzymes for the food industry (Case B_Interview, Pos. 33).

Thus, the firm evaluates its innovation outcomes in particular with regard to environmental sustainability and ethical criteria, which are also ensured by industry standards. However, meeting these criteria does not appear to be a hurdle for the firm, as the interviewee describes: “Most of the requirements are not difficult for us to meet, because, as a still quite young company, we have paid attention to sustainable developments and production processes right from the start. We have modern facilities that allow us to produce both efficiently, cost-saving but also sustainable, and therefore this is usually no problem for us” (Case B_Interview, Pos. 35). These highly efficient and sustainable production facilities put the firm in a strong position in the competitive environment: „The focus on sustainability in the production process has advantages for us, as we have more favorable cost structures than our competitors due to our resource-conserving and energy-saving production processes” (Case B_Interview, Pos. 35).

Regarding the *iterative* elements in the innovation process, the interviewee states that this does not only happen at the end of an innovation process:“That actually happens all the time in our company. I would say that this is also somewhat due to the young corporate culture that we regularly question things and reassess them” (Case B_Interview, Pos. 37). These findings are then discussed at management level and fed back into planning and strategy development.

Regarding the element of *transparency*, the firm by regulation needs to publish and meet several criteria for its products for the food industry. For the other activities, the firm also works with many partners, but the interviewee emphasizes that the protection of intellectual property also plays an important role. “We are always open to discussions and also try to present ourselves transparently, especially when it comes to the safety of our products and standards. I would say that there is not always a super-transparent insight into the research projects in our pipeline, because this is also part of the core competencies, which we naturally also want to protect” (Case B_Interview, Pos. 41). In some cases, the firm also publishes in scientific journals.

In summary, the sustainability and resource efficiency of case firm B’s production processes are a key competitive advantage that, while not directly embedded in its vision and mission, is anchored in its corporate strategy. The collaboration with stakeholders in the innovation process is also part of the corporate strategy. There are clear criteria for the ethical and environmental assessment of innovation outcomes and regular phases of iterative reflection, in which employees are also involved. Since some innovation activities are not so transparent for IP reasons, the Advisory Board is also involved in addition to the employees in anticipating innovation outcomes.

4.2.3. Case firm C

Case firm C is a university spin-off, founded in 2019, that received seed VC funding. The firm developed a technology to make use of by-products and waste from industrial processes by extracting and processing a biopolymer that can be used for various applications. Including the cosmetics industry, the textile industry and the food industry. The interview was conducted with the founder and CEO of the firm, who was familiar with the RI concept. This may be since the interviewee has been intensively involved with the valorisation of by-products for the last ten years. Regarding the motivation for developing innovations, the interviewee stated: "I really do believe in this like full complete cycle of usage of the material" (Case C_Interview, Pos. 22) and that now was "the right time to do something for the world and other people. […] We need quick solutions for global problems" (Case C_Doc1). The high personal passion becomes especially clear as the interviewee stated several times to really believe in and really love it (Case C_Interview, Pos. 22). This shows that the purpose of founding the firm was already aligned with the RI values.

The *purpose* elements of the conceptual framework can also be found in the firm's characteristics. Firstly, the firm is intensively engaged with the UN SDGs and has also integrated them into the corporate vision and mission. The mission includes the statement "creating value from sustainability" (Case C_Doc5). The vision includes specifically selected UN SDGs that address both the innovation strategy and the general firm strategy. Regarding the firm's innovations, they are committed to "SDG 12: Responsible consumption and production", "SDG 13: Climate action" and "SDG 14: Life below water" (Case C_Doc6). In addition, the "SDG 3: Good health and well-being" (Case C_Doc6) is aiming at both their own employees and the users of their products. The "SDG 5 and SDG 8" (Case C_Doc6) are also integrated into the vision and refer to "how we are working" (Case C_Interview, Pos. 70). The interviewee stated that the integration of clear goals was important, as many companies do greenwashing by only focussing on one pillar of sustainability, and instead "cover […] different areas of what sustainability means" (Case C_Interview, Pos. 24) and that "the UN has put [the goals] there for us to follow, to reach the targets or to reach the agenda" (Case C_Interview, Pos. 24).

The integration of the UN SDGs is an iterative process in the firm and is frequently checked, so the firm plans to integrate the SDG 17: "partnership for the goals and this is something we will be doing" (Case C_Interview, Pos. 70).

In strategy development processes, the firm actively involves the employees in "brainstorming of how the team thinks about the whole environment, what will be for them important for the innovation strategy" (Case C_Interview, Pos. 54). The interviewee highlights that it is crucial that "the team is aligned with the mission, with the vision, with what we want to do" (Case C_Interview, Pos. 54).

Concluding the purpose element of the conceptual framework, the case firm meets all proposed elements by integrating UN SDGs in both firm and innovation strategy, the mission and vision and involves its employees in strategy development to make sure the whole team is aligned behind the same goals.

Looking at the *innovation process* element of the framework, the case firm practices *stakeholder involvement* especially in product development by product testing in the cosmetics industry, and by collaborating with industry partners who generate the by-products and waste products that are then required as starting material for the firm. As the firm is still relatively small, the same concerns the number of cooperation partners. Regarding cooperation partners, the interviewee states that they "want to have a sustainable value chain, […] everybody has to be aligned" (Case C_Interview, Pos. 30). This means, that for testing partners in, e.g., the cosmetic industry, that they "of course [...] check" (Case C_Interview, Pos. 28) the firms regarding their sustainability efforts. However, it is also

emphasized that the companies that want to cooperate with the case firm are "willing to change materials and to pay these premium prices for bio-based materials, they are already on a very good track" (Case C_Interview, Pos. 28).
Suppliers of by-products are scrutinized even more closely for their sustainability and use of toxic chemicals to ensure that the source material is safe and produced under fair and good standards. To ensure these standards, they "need to have a lot of information from [their] suppliers. Like really, they kind of have to go naked with us" (Case C_Interview, Pos. 50).
The firm does not actively seek for stakeholders to expand knowledge and competencies, as their technology is already mature. However, the firm has an Advisory Board, which is composed of experts from science and industry (Case C_Doc5).
Thus, the involvement of stakeholders is limited to direct cooperation partners, who are screened prior to cooperation to determine whether they can meet the case firm's sustainability standards and values.
Regarding the *anticipation* of negative innovation outcomes, the firm carries out activities to prevent negative effects by themselves. Therefore, the firm develops an algorithm checking the suitability of the bio-based polymer material in the particular use case: "An algorithm as to what products to go for and what products not to go for "(Case C_Interview, Pos. 34). As an example, the interviewee describes experiments to anticipate "the impact of the [material] in the water, if there will be some problems with the fishes, as there is with micro plastics" (Case C_Interview, Pos. 34). And as a consequence, the firm rejects client requests that would not be aligned with the firm's sustainability values: "the kind of projects that even if probably this is a client that is bringing us money, this is absolutely nonsense. And we will not accept these kind of things" (Case C_Interview, Pos. 34).
The framework element of *knowledge management* "is really, really important" (Case C_Interview, Pos. 46) for the firm, as they are a small team (<10 employees) that cannot cover all areas of expertise. Therefore, the firm relies on "a very extensive network of people helping like laboratories, research institutes, universities, companies that are doing subcontracting" (Case C_Interview, Pos. 46).
Concerning the *outcome* element of the conceptual framework, the company relies now solely on environmental criteria by conducting "lifecycle assessment […] with a subcontractor" (Case C_Interview, Pos. 36). Regarding social and ethical criteria to evaluate innovation outcomes, the interviewee states that they "do not have that" (Case C_Interview, Pos. 40). In addition, the interviewee states that the evaluation criteria are still to be developed, but that they first "want to implement ourselves like a solid concept before we get it analysed" (Case C_Interview, Pos. 36). Thus, only environmental criteria have been evaluated so far, but for the future, a more holistic evaluation by an external party is planned to see if they "are actually doing sustainable work, if [they are] working on the SDGs" (Case C_Interview, Pos. 36).
Regarding the *iterative* process not much can be said in this case other than, that the firm is young and in its first strategy development processes and developing criteria for assessment of results. But the future plans of the firm, e.g., for the integration of further UN SDGs in the vision or the joint development of a concrete innovation strategy show ambitions with iterative elements.
Regarding the *transparency* element of the conceptual framework, the firm tries to be transparent regarding their sustainability values and high standards in innovation development and internal firm processes, which is also shown by various interviews with newspapers and the blog and elaborations on the firm website (Case C_Doc4). Regarding their patented technology, the firm is not quite as transparent, as they see this as a competitive advantage that cannot be disclosed. For cosmetic applications, the firm has to apply for approval of its products as cosmetic ingredients and disclose everything, including its technology, for the safety assessment to a commission. „This is what [they]

can present to the customers" (Case C_Interview, Pos. 50) and use this approval via standards as transparent proof of their product without disclosing the details of the technology and they "don't plan to tell [their] customers how [they are] handling the material" (Case C_Interview, Pos. 50).
In summary, the firm complies with all elements of the conceptual framework with minor lacks in assessment of innovation outcomes by social or ethical criteria, transparency, regarding their technology towards the outside and a broader stakeholder involvement than just their business partners. In the firm the fundamental principles of RI are strategically implemented in both the firm and innovation strategy. Beginning with the orientation towards UN SDGs that are embedded in the corporate mission and vision and the conviction of the founder, to build up a strong competitive advantage in the long term by following RI values since "many companies in Germany they really want to switch to biobased products and they really care about the CO2 footprint in the whole value chain of the products" (Case C_Interview, Pos. 20).

4.2.4. Case firm D

Case firm D has a twofold portfolio, focusing on plant breeding and on the one hand industrial biotechnology processes like biorefineries and genome editing, as well as products such as biologically produced aromas. On the other hand, the firm was originally founded with the aim of carrying out agricultural field trials for genetic engineering as a service, but this was banned in the EU a few months after its foundation. Since then, the firm has had to build up its other businesses. In recent years, the firm has also acquired expertise in genome editing in plant breeding, as it expected this process to now also be approved in the EU. However, this has not happened to date.
The interview was conducted with the CEO and founder, who was not familiar with the RI concept.
The motivation of the firm towards innovation development for the plant breeding segment is on development of „plant breeding for the use of renewable raw materials that make it possible to transform pharmaceutical production or even food production to a healthier, more sustainable and simple production method. Through genome editing" (Case D_Interview, Pos. 7). This means that plants are optimized in such a way that they produce a higher quantity of the desired ingredients and, at the same time, take up less usable land, for example. The firm justifies the relevance of genome editing by saying that this method is much safer and more targeted than methods using chemistry or radiation. In addition, the interviewee says the use of genome editing could also significantly contribute to the achievement of the EU Green Deal goals, according to EU assessments. "If genome editing is not allowed or cannot be commercially marketed in Europe [...] we cannot achieve the green deal, i.e., the climate protection goals" (Case D_Interview, Pos. 6).
In the other part of the firm, the innovation motivation is similar. It is the goal to "convert petrochemical production processes to natural or biotechnological production processes from renewable raw materials" (Case D_Interview, Pos. 7). In general, the company has the ambition to „always be at the forefront of development with [their] offers" (Case D_Interview, Pos. 9).
Regarding the *purpose* element of the conceptual framework, the firms mission states that they want to develop products by plant-inspiration, like the biomimicry concept to transform chemical production to bio-based products. "We are inspired by plants, i.e. by nature, as to which products we can reasonably produce at all" (Case D_Interview, Pos. 19). This questioning of how and what to innovate at all is a key characteristic of RI. The firm documents or the interviewee do not refer directly to the UN SDGs, but overlaps can be seen in the goals. This applies not only to the innovation strategy, but also to the other areas of the firm, as the interviewee repeatedly emphasizes the "social aspects"

(Case D_Interview, Pos. 23) of his responsibility towards the employees and “the creation and securing of new jobs in Germany” (Case D_Interview, Pos. 31). The interviewee also highlights the diversity and variety of his staff in the company, where “70% women” work and around “half of the employees have a background of migration” (Case D_Interview, Pos. 21).
Strategic decisions such as the „mission or vision and slogans and the goals of the company are also discussed and developed in a larger group” of employees (Case D_Interview, Pos. 23).
Looking at the *innovation process* elements of the conceptual framework, the firm engages in different forms *stakeholder involvement*. Also, the firm is involved in various research projects, some of them publicly funded. The goal of these projects from the firm’s point of view is to "improve the technologies" and get information through the partners: “What is up to date in Academia right now, and where do we definitely need to make adjustments to remain competitive?” (Case D_Interview, Pos. 11).
In addition, the firm is engaged in projects „to increase the public acceptance of genome editing and to better explain the technology to the public” (Case D_Interview, Pos. 31). These projects involve a great deal of public relations work, participation in public discussions, and explanation of the benefits and risks of the technology. Even though the strategic goal of these efforts for the firm is, of course, to get the technology approved in Europe, this kind of wider stakeholder involvement is a key characteristic of the RI concept.
Regarding the question of the *anticipation* of possible negative innovation outcomes the interviewee stated, that „this question does not really arise, because we always try to find sustainable and ecologically sensible solutions” (Case D_Interview, Pos. 29). Furthermore, the firm actively engages in public discussions on the need for genome editing to reach climate targets, which also triggers public discussions about the safety and possible negative consequences.
As for the component of *knowledge management* it is already stated above that the firm engages in cooperation projects to update its knowledge and technology by getting input from external partners. In addition, the interviewee states that a major asset of the firm is “the know-how of the employees. Without them, I could not do these things at all and we have a very loyal workforce and therefore we have the expertise through our employees in the firm” (Case D_Interview, Pos. 35).
Looking at the *outcome* element of the framework, the case firm *assesses the innovation outcomes* by primarily using environmental criteria. On the one hand, these include a sustainability tool that assesses the company as a whole in terms of sustainability and identifies potential for improvement. On the other hand, life cycle assessments are also prepared depending on the project. An important criterion here is the land use index, i.e., “how many hectares of agricultural land can be saved” (Case D_Doc4). In addition to the environmental aspects, the “social acceptance of the technology” (Case D_Interview, Pos. 31) is also considered as a social criterion. This reflects the question of the RI concept regarding the social desirability of an innovation.
Regarding the *iterative process* the interviewee emphasizes, that „not only at the end but actually all the time” (Case D_Interview, Pos. 37) the status quo is questioned in the firm and strategic decisions adjusted. This is especially due to the fact that “a solution, is not always the final solution, but a solution naturally also raises new questions” (Case D_Interview, Pos. 37). The interviewee points out that for them, “an improvement in sustainability naturally also means an improvement in profitability” (Case D_Interview, Pos. 37), which makes the iterative process of reflection on innovation outcomes an essential practice with a strategic direction.
Lastly, regarding the framework element of *transparency*, the interviewee emphasized that they are very transparent regarding their products and innovation processes and publish findings in scientific journals. The first reason why they are transparent is justified by the fact that “the know-how of the

firm [...] is anyway due to the employees" (Case D_Interview, Pos. 35). Regarding the activities of genome editing, the interviewee states that they must be proactively with the aim to explain the technology to the public and to increase the acceptance of the technology in society (Case D_Doc3). Since the case firm sees the technology as "much more targeted and much, much more careful. [...] Without inserting further mutations that you do not want to have or that have negative consequences" (Case D_Interview, Pos. 6), this shows that their intention is also to prevent negative consequences, a major element of the RI concept.
In summary, case firm D acts according to the elements of the conceptual frameworks for RI. Although not specifically anchored in its mission and vision, the firm is strategically oriented towards solving sustainability-oriented UN SDGs and also values other SDGs in their general firm strategy which is shown by high diversity and the awareness of social responsibility towards their employees. The firm practices stakeholder involvement beyond research collaborations and is engaged in public discussions regarding the use and safety of genome editing technology, a key characteristic of RI. Anticipation practices are lacking, except for the stakeholder involvement in the case of the genome editing technology, and knowledge management is practiced trough both internal and external sourcing. For the assessment of innovation outcomes, clear environmental criteria are used and additionally the criterion of social desirability are considered. The firm acts very transparent, both due to requirements and proactively. As for the strategic implementation characteristics, the firm practices its sustainability efforts and stakeholder involvement to gain a competitive advantage, increase profitability and tackle grand challenges, such as the climate change. Although not clearly formulated, the strategy seems to be anchored in the firms decision-making and iterative processes of reflection.

4.2.5. Case firm E

Case firm E focusses on marine biotechnology by generating ingredients from the oceans that can be used for cosmetic applications, medical applications, and the food industry. This includes, among other things, the use of sustainable algae farms and the extraction of bio-based active ingredients from them.
The interview was conducted with the CEO who was not directly familiar with the concept of RI. Nevertheless, the interviewee was familiar with all elements of RI due to intensive exploration of the concept of economy for the common good (ECG) in the firm, which has similar values. It is an economic model "which makes the common good, a good life for everyone on a healthy planet, its primary goal and purpose" (Case E_Doc5).
The firm was established by a team of marine biologists with a "strong motivation of marine protection" (Case E_Interview, Pos. 10), with the purpose of "making marine natural products available for human health" (Case E_Interview, Pos. 8). This *purpose* is also still reflected in the firm's vision of being "the world's leading 'treasure collectors' of active ingredients from the sea" (Case E_Doc2). While the *mission and vision* do not directly address RI values, the firm communicates very clearly and specifically its core values, which are aligned with RI. These core values include "sustainability, responsibility for people and the environment, freedom and creativity" (Case E_Doc2). In addition, the firm's *code of conduct* includes "empathy, diversity and respect" especially towards people with "different needs, perspectives and opinions" (Case E_Doc2), which are aligned with the dimensions of inclusion and reflexivity of RI. The firm also identified core UN SDGs that fit to the firm's purpose and where it has set itself the goal to contribute to their solution. „We worked out quite quickly and clearly a prioritization of SDGs 8, 13 and 14, i.e., human dignity,

climate and ocean protection. Health, partnerships and sustainable production (SDGs 3, 12, 17) are also important to us, but rather in the middle range in terms of priority" (Case E_Doc1). The firm has decided to prioritize the SDGs, since "all SDGs are essential for the survival of humankind, but not all SDGs are equally relevant to our everyday actions" (Case E_Doc1).
The firm has also committed itself to working on behalf of its employees, which includes "fair employment contracts with an eco-pension plans" as well as "encouraging employees to find out where their talents and passions lie, so that they can grow and develop freely in their careers" (Case E_Doc2), which should reflect the actions towards SDG 8.
The interviewee states that in this whole strategy development process and in the formulation of the code of conduct, usually the whole team is involved to make sure that everybody is aligned with the values: "In the end, this is negotiated and discussed almost grassroots-democratically, I would say" (Case E_Interview, Pos. 20).
Regarding the *innovation process* elements of the conceptual framework, the interviewee highlights that *stakeholder involvement* "corresponds to [their] strategy of [...] Open Innovation" (Case E_Interview, Pos. 38). Thus, the firm collaborates in R&D with universities, research institutes and other firms and selects its partners in these partly funded projects by the criterion of expertise. The interviewee emphasizes that it is their conviction that "when innovations are shared with many, that of course you also make faster or better progress in the area in particular and can tap into markets that were not covered before and where you realize, actually, we wouldn't have been able to do it by ourselves" (Case E_Interview, Pos. 38).
Regarding the *anticipation* of negative innovation outcomes, the interviewee said that new ideas and projects "are presented to a large group [internally], then they are discussed and [...] we talk a lot about, let's say, what the ethical consequences of this innovation would be" (Case E_Interview, Pos. 20). These checks, especially with employees who are particularly knowledgeable, are sometimes carried out by means of anonymous "internal surveys, where everyone can give their assessment" (Case E_Interview, Pos. 22). As a guiding principle from the code of conduct, the „respect for people with different opinions" (Case E_Doc2) helps with anticipation of negative innovation outcomes.
As an example, the interviewee mentioned a project where the technology was quickly pushed forward, but then during the development process, it was determined by other employees that the sustainability was not sufficiently guaranteed or the solution was not ethical enough and the project was therefore stopped, even if it would have made economic sense.
Regarding the framework element of *knowledge management,* the firm usually first tries to "fill the gaps internally" (Case E_Interview, Pos. 28). If the knowledge gaps cannot be closed in this way, they try to "get advice from fellow companies, maybe do a collaboration with them, and that often works very well. Because the market is big enough [...] that certain technologies or applications or products can also be well shared" (Case E_Interview, Pos. 28).
The *outcomes* of the innovation process are *assessed* by the use of formal environmental, social and ethical criteria. Starting with the environmental criteria, the firm mainly uses life cycle assessments where "one of the more important indicators certainly is the CO2 footprint" (Case E_Interview, Pos. 30). In this context, the company evaluates "the entire manufacturing and supply chain", including emissions in everyday office life and takes measures, such as the sourcing from "controlled organic production from sustainably operating suppliers" or the use of green energy and equipping employees with bicycles to get to work (Case E_Doc2).
Other criteria include "social responsibility" and "what do you contribute back to society" (Case E_Interview, Pos. 30); criteria that are particularly relevant in the context of the ECG initiative, but also align with RI's values. The firm is currently attempting to develop these social and ethical

indicators as part of an ECG balance sheet and is still in the process of doing so. However, the interviewee provided the example that they "no longer sell their products on Amazon due to the ethical issue of the firm's social and working conditions" (Case E_Interview, Pos. 26), as well as "changes in corporate communications and language to be inclusive and gender equitable" (Case E_Interview, Pos. 32).

Regarding the *iterative* element of the framework the firm highlights that "capturing the status quo as a basis for concrete action is essential. Where do we stand now? How can we become even more sustainable, even better?" (Case E_Doc2). The interviewee confirmed that this process of reflection is especially important for the firm happens regularly and stated: "We must also take a self-critical look at ourselves and not simply say: Yes, we are already sustainable. We are making an effort to do this right" (Case E_Interview, Pos. 40).

Concerning the element of *transparency,* the interviewee explains, that transparency is seen as a "crucial advantage in attracting customers that buy natural cosmetics and pay attention to environmental and marine protection" (Case E_Interview, Pos. 34). As their customer segment values transparency, the value chain is fully disclosed and the firm reports on the values and responsible measures it takes on its website.

Regarding scientific findings, the firm is relatively open about it and publishes the findings. "There are a few areas where we say okay, this is now really so specific and so special and perhaps contains important economic applications in the future. We have then patented these" (Case E_Interview, Pos. 38). This high transparency is also due to the firm's additional mission to "spread knowledge about the sea and its wildlife" (Case E_Interview, Pos. 38), because the oceans are still not explored as much as other areas, e.g., space.

In summary, the firm's efforts in the context of the ECG initiative meet all elements of the conceptual framework for RI due to the similarity of the concepts. It must be emphasized that the firm has developed a comprehensive code of conduct that includes a focus on the UN SDGs, social and ethical core values, and ways of working to implement their strategy. The firm has also developed clear criteria that are used to regularly evaluate products and processes within the firm in an iterative process. As a distinctive feature of its strategy, the firm aims not only to be economically successful in the first place, but also to give back to society, nature, science and its employees through its ECG orientation.

Summary of all cases

In conclusion, looking across all cases, the firms practically apply the elements of the conceptual framework for strategic implementation of RI despite different demographic characteristics, firm size (within the SME range), thematic focus within the biotech industry, and maturity level; even though only one of five interviewees was familiar with the terminology and concept of RI. The insensitivity of RI practices and values varies and the firms have different priorities. This can be seen, for example, in whether the firms only pursue a general sustainability approach or whether specific goals, such as the UN SDGs are integrated into the innovation or corporate strategy, or whether transparency is only granted by regulatory requirements or is proactively granted beyond them. The different levels of the individual RI elements of the conceptual framework at the case firms are compared step by step in the following section.

4.3. Comparative analysis of the strategic implementation of RI in Biotechnology SMEs

In the following section, a comparative analysis of the cases is conducted, step by step along the dimensions and elements of the conceptual framework. Differences, similarities, and particularities between the cases are highlighted.
For each element of the conceptual framework that was identified in the case firms, the significant quotes are summarised in tables. The quotes in the tables are grouped by sub-categories according to the different characteristics of the framework elements and sorted by case firm.

4.3.1. Purpose

The first dimension of the framework is the purpose dimension, including the elements of the RI code of conduct, which should, according to the framework serve as policy document where the strategic directions are noted down. This should include an orientation towards (selected) UN SDGs and the values reflected in the RI dimensions (see Table 4).
Regarding an orientation towards UN SDGs in the innovation strategy, the SDGs were explicitly mentioned by two out of five case firms, including case firms C and E. They selected specific UN SDGs based on their direction of innovation and committed themselves to working towards solving them (see sub-category *UN SDGs in Innovation strategy* in Table 6). Case firm D is similarly committed to solving societal problems, such as UN SDGs 2, 12 and 13 through its innovations but has not used the UN SDGs to write them down. Likewise, firm B is oriented towards sustainable innovations that can be reflected in UN SDGs 3, 9, 12 and 13. But, the firm explicitly puts the economic success first and has not used the SDGs to define a strategic innovation direction. Case firm A is a bit different from the others, as e.g., sustainability is not mentioned in connection with strategic orientation, but is taken for granted without clear justification. The interviewee was not directly familiar with the UN SDGs, but their innovation orientation overlaps with UN SDGs 3, 6 and 14.
Since for a strategic implementation of RI not only the innovation processes, but also other areas within the firm are relevant, the next element of the RI code of conduct concerns the integration of the values into the overall strategy (see sub-category *UN SDGs in firm strategy* in Table 6). Even though the specific reference to the UN SDGs was only found in cases C and E, responsible elements that could be identified through UN SDGs in the firm strategy, were found for all cases, some of which are driven by the founders. They include the creation of jobs (SDG 8), the avoidance of waste within the firm (SDG 12), diversity and inclusion among the employees (SDGs 5 and 10).
In the RI code of conduct proposed in the conceptual framework, the RI dimensions Responsiveness, Anticipation, Inclusion and Reflexiveness and other values should be anchored in addition to an orientation towards the UN SDGs (see Table 4). This code of conduct should be the basis for daily actions and decisions and ensure the implementation of RI.
In the case firms, the use of a code of conduct for RI is only found in case firm E, which also discloses it transparently on their website (see sub-category *Guiding principles* in Table 6). Their code of conduct, which is referred to as the guiding principles, also includes RI dimensions such as Inclusion, Responsiveness and Reflexivity. In the other firms, formal guidelines like a code of conduct to ensure responsible action were not found. However, the notion of such RI core values was identified in case firm C, where these core values can be recognised in particular from the personal motivation for ecological solutions of the founder, who, due to the very small number of employees, can ensure this through less formal instruments than a written code of conduct.

Table 6. Extractions for the RI Code of conduct element of the framework

Category	Sub-Category	Quotes
Code of Conduct	*UN SDGs in Innovation strategy*	"[Products] are all sustainable and have no negative impact on climate change" (Case A_Interview, Pos. 16)
		sustainability values are top priority although "conditional upon an economic success that is superior to it" (Case B_ Interview, Pos. 9).
		"as a general rule, we produce CO2-neutral. Of course, this is not always or not yet always possible, but this is our goal" (Case B_ Interview, Pos. 33)
		"SDG 12: Responsible consumption and production", "SDG 13: Climate action" and "SDG 14: Life below water" (Case C_Doc6) "SDG 3: Good health and well-being" (Case C_Doc6)
		„Plant breeding for the use of renewable raw materials that make it possible to transform pharmaceutical production or even food production to a healthier, more sustainable and simple production method. Through Genome Editing" (Case D_Interview, Pos. 7) "convert petrochemical production processes to natural or biotechnological production processes from renewable raw materials" (Case D_Interview, Pos. 7)
		"all SDGs are essential for the survival of humankind, but not all SDGs are equally relevant to our everyday actions" (Case E_Doc1) „We worked out quite quickly and clearly a prioritization of SDGs 8, 13 and 14, i.e., human dignity, climate and ocean protection. Health, partnerships and sustainable production (SDGs 3, 12, 17) are also important to us, but rather in the middle range in terms of priority" (Case E_Doc1)
	UN SDGs in firm strategy	"we are of course working to secure jobs here" (Case A_Interview, Pos. 10)
		"reducing plastic waste and finding solutions for the further use of the unavoidable laboratory waste from plastic" (Case B_Doc4)
		"SDG 5 and SDG8" (Case C_Doc6) refer to "how we are working" (Case C_Interview, Pos. 70) "partnership for the goals and this is something we will be doing" (Case C_Interview, Pos. 70)
		"70% women and around half of the employees have a background of migration" (Case D_Interview, Pos. 21) "social aspects" (Case D_Interview, Pos. 23) of his responsibility towards the employees and "the creation and securing of new jobs in Germany" (Case D_Interview, Pos. 31)
		ECG is an economic model "which makes the Common Good, a good life for everyone on a healthy planet, its primary goal and purpose" (Case E_Doc5) "We have now supplemented it with [...] SDG 8 was, I think, somehow to create responsible jobs, working environments" (Case E_Interview).
	Guiding principles	"cover […] different areas of what sustainability means" (Case C_Interview, Pos. 24) and "the UN has put [the goals] there for us to follow, to reach the targets or to reach the agenda" (Case C_Interview, Pos. 24)
		"sustainability, responsibility for people and the environment, freedom and creativity" (Case E_Doc2). "empathy, diversity and respect" especially towards people with "different needs, perspectives and opinions" (Case E_Doc2) "fair employment contracts with an eco-pension plans" as well as "encouraging employees to find out where their talents and passions lie, so that they can grow and develop freely in their careers" (Case E_Doc2)

In the proposed conceptual framework, it is recommended to implement elements of responsibility - agreed upon in the RI code of conduct – into the mission and vision statements of the firm to ensure strategic implementation of RI. This notion of RI can be identified in four out of five mission or vision statements of the case firms (see sub-category *statement* in Table 7). Only case firm B does not specifically address values of RI in their statement.

Table 7. Extractions for the Mission & Vision element of the framework

Category	Sub-Category	Quotes
Mission & Vision	*Statement*	"We develop biological, eco-friendly, cost-effective solutions to environmental, food and biotechnology problems." (Case A_Doc5)
		"becoming a global leader in tomorrow's biotechnology sector" (Case B_ Interview, Pos. 17)
		"creating value from sustainability" (Case C_Doc5) "SDG 12: Responsible consumption and production", "SDG 13: Climate action" and "SDG 14: Life below water" (Case C_Doc6)
		"We are inspired by plants, i.e. by nature, as to which products we can reasonably produce at all" (Case D_Interview, Pos. 19)
		"making marine natural products available for human health" (Case E_Interview, Pos. 8)
	Founder's motives	"I really do believe in this like full complete cycle of usage of the material" (Case C_Interview, Pos. 22) and that now was "the right time to do something for the world and other people. […] we need quick solutions for global problems" (Case C_Doc1).
		„always be at the forefront of development with [their] offers" (Case D_Interview, Pos. 9)
		"strong motivation of marine protection" (Case E_Interview, Pos. 10)
	Employee involvement in strategic decisions	"in the past, the whole team was involved. Now, of course, we have grown considerably, and we have built up two strong management levels. Here, of course, the strategy processes now mainly take place, but of course the opinions of the employees are always reflected and included" (Case B_ Interview, Pos. 19)
		"brainstorming of how the team thinks about the whole environment, what will be for them important for the innovation strategy" (Case C_Interview, Pos. 54). crucial that "the team is aligned with the mission, with the vision, with what we want to do" (Case C_Interview, Pos. 54).
		„mission or vision and slogans and the goals of the company are also discussed and developed in a larger group" of employees (Case D_Interview, Pos. 23)
		"In the end, this is negotiated and discussed almost grassroots-democratically, I would say" (Case E_Interview, Pos. 20)
	Competitive advantage	"If you participate in publicly funded projects, you must fulfil ethical and sustainable principles, otherwise you do not get a project approved" (Case A_Interview, Pos. 42)
		„The focus on sustainability in the production process has advantages for us, as we have more favourable cost structures than our competitors due to our resource-conserving and energy-saving production processes" (Case B_Interview, Pos. 35)
		"many companies in Germany they really want to switch to biobased products, and they really care about the CO2 footprint in the whole value chain of the products" (Case C_Interview, Pos. 20)
		"an improvement in sustainability naturally also means an improvement in profitability" (Case D_Interview, Pos. 37)
		"crucial advantage in attracting customers that buy natural cosmetics and pay attention to environmental and marine protection" (Case E_Interview, Pos. 34)

In SMEs, the purpose of the firm is often aligned with the motivations and values of the founder, who has a strong influence on the firm culture. Since four out of five interviews were conducted with the founder and the mission often strongly correlates with their motivation, these sub-categories are also integrated into this analysis of mission and vision (see sub-category *Founders motives* in Table 7). For case companies C and E, the establishment of the firm was already linked to the solution of grand challenges. In the case of firm C, the goal of a circular economy and in the case of firm E the protection of the oceans were personal motives of the founders for establishing the firm. For case firm D the motivation to start the firm lied in research excellence and the goal to push forward science by always working with state-of-the-art technology. For case firm A, the motivation for launching the business could not be identified in the interview. As the interview with case firm B was not conducted with the founder, no assessment can be made in this regard.

As proposed with the conceptual framework, the strategic implementation of RI should be carried out by organizational engagement. In the study it could be identified that firms B, C, D and E involve their employees in (strategic) decisions and processes to ensure that everybody is aligned behind the mission, vision and values of the firm. Due to the medium size of case firm B, the involvement of all employees is not possible anymore, but in smaller groups still practiced. For case firm A, employee involvement in strategic decisions could not be identified; it could be assumed that decision-making processes may be more centralised in this case.

A crucial element of strategic implementation is the orientation of plans and actions in obtaining benefits or a competitive advantage. This orientation towards improving the competitive positions by pursuing activities aligned with RI, could be identified in all cases (see sub-category *Competitive advantage* in Table 7). Case firm A is dependent on public funding to cover the costs of the firm and must meet certain sustainable or ethical criteria. Due to the high eco-efficiency of the production processes in case firm B they have a cost-advantage over their competitors. Case firm C offers bio-based materials that are increasingly needed by large corporations that want to or must switch to more sustainable products. Case firm D stated, that for them, improvements in sustainability lead to higher profitability. For case firm E, the high standards and responsible actions are especially valued by their customer segment that is willing to pay premium prices.

4.3.2. Process

Stakeholder involvement in all phases of the innovation process is a crucial element of the RI concept. All case firms integrate stakeholders in the innovation process by applying the concept of OI. They collaborate with other firms, universities or research institutes in research or development projects (see sub-category *Stakeholders* in Table 8). In some cases, these collaboration projects are publicly subsidized, e.g., by the EU or the German Federal ministry of Education and Research. The purpose of the collaboration in most cases is the exchange of information and competencies or outsourcing (see sub-category *Purpose* in Table 8). Case firms A, C, D and E (plan to) collaborate with external service providers who assess the responsibility or sustainability of their processes and innovation outcomes. Firm B and D work closely with their customers in innovation development.

A broader (public) involvement of stakeholders is only practised by firm D. They engage in public discussions about their genome editing technology with the intention to explain it to the public and raise the acceptance.

For the other firms, the stakeholders to be involved are specifically selected. The expertise and personal fit of the partner is usually the relevant criterion (see sub-category *Involvement criteria* in

Table 8). For case firms C and E, the partners engaged in their value chain (upstream and downstream) also must comply with the same ecological, social and ethical standards they have set for themselves. Therefore, these partners must then prove these standards or disclose their processes.

Table 8. Extractions for the Stakeholder involvement element of the framework

Category	**Sub-category**	**Quotes**
Stakeholder Involvement	*Stakeholders*	"Universities, research institutes, public institutes, Fraunhofer institutes, but also companies" (Case A_Interview, Pos. 26)
		"we work closely with our customers in all phases of the innovation process" (Case B_ Interview, Pos. 21)
		"laboratories, research institutes, universities, companies that are doing subcontracting" (Case C_Interview, Pos. 46)
		projects „to increase the public acceptance of genome editing and to better explain the technology to the public" (Case D_Interview, Pos. 31)
	Purpose	„providing each other with information" (Case A_Interview, Pos. 36).
		"responsible for life cycle assessments" (Case A_Interview, Pos. 48) and "revealing which aspects are not sustainable" (Case A_Interview, Pos. 54)
		"cooperation is a key business element" (Case B_Doc1) "we participate in this regulatory criteria and processes and in the development of standards for enzymes in food technology" (Case B_Interview, Pos. 33)
		get information through the partners: "What is up to date in Academia right now, and where do we definitely need to make adjustments to remain competitive?" (Case D_Interview, Pos. 11)
		"corresponds to our strategy of […] Open Innovation" (Case E_Interview, Pos. 38)
		"when innovations are shared with many, that of course you also make faster or better progress in the area in particular and can tap into markets that were not covered before and where you realize, actually, we wouldn't have been able to do it by ourselves" (Case E_Interview, Pos. 38)
	Involvement criteria	"expertise or [...] competencies" (Case B_Interview, Pos. 23)
		"want to have a sustainable value chain, […] everybody has to be aligned" (Case C_Interview, Pos. 30). "willing to change materials and to pay these premium prices for bio-based materials, they are already on a very good track" (Case C_Interview, Pos. 28) "need to have a lot of information from our suppliers. Like really, they kind of have to go naked with us" (Case C_Interview, Pos. 50)
		"First of all, it's a professional fit, then it's a personal fit." (Case E_Interview, Pos. 26)
		"the entire manufacturing and supply chain", including sourcing from "controlled organic production from sustainably operating suppliers" (Case E_Doc2).

Regarding the element of anticipation of innovation outcomes, firm A stated that they do not practice anticipation (see sub-category *Method*s in Table 9). Firm B referred to the high standards of research and emphasised that they assess risks and possible negative outcomes by involving their advisory board, which is composed of experts from science and business (see sub-category *Internal and external Stakeholders* in Table 9). Firm C does not involve stakeholders for the anticipation of negative innovation outcomes but chose a more technological assessment of the risks. They conduct experiments and develop an algorithm that evaluates the compatibility of their technology in different

use cases (see sub-category *Technical Assessment* in Table 9). They emphasized that projects with possible negative consequences have already been stopped in the past.
Case firm D points out that the question of possible negative consequences does not arise as they always try to find responsible solutions. However, their projects with genetically modified plants have been stopped by an EU moratorium in the past. Thus, the firm does now involve the public in the discussion of the approval of the improved genome editing technology in the EU, which also contains discussions about safety, ethical and social desirability and sustainability. Therefore, firm D is the only one, from the cases studied, that fulfils RI's definition of broad, democratic and public involvement of societal actors to some extent.
Firm E has established a quite formalised process for the critical assessment of possible negative innovation outcomes in which they take social, ethical and environmental criteria into account. For this purpose, regular discussions and anonymous surveys are conducted, but only internally among their employees. However, their guiding principles emphasize transparency of their development processes and respect for people with different opinions, an element which is also relevant for the anticipation of risks (see sub-category *Internal and external Stakeholders* in Table 9).

Table 9. Extractions for the Anticipation element of the framework

Category	**Sub-Category**	**Quotes**
Anticipation of innovation outcomes	*Methods*	"We don't actually do that" (Case A_Interview, Pos. 30)
		"according to the general principles of research and pay attention to ethical and environmental protection aspects" and "consider the possible negative consequences that may occur and also assess the risks here" (Case B_Interview, Pos. 27)
		„this question does not really arise, because we always try to find sustainable and ecologically sensible solutions" (Case D_Interview, Pos. 29)
	Technical assessment	"An algorithm as to what products to go for and what products not to go for "(Case C_Interview, Pos. 34) "the kind of projects that even if probably this is a client that is bringing us money, this is absolutely nonsense. And we will not accept these kind of things" (Case C_Interview, Pos. 34). anticipate "the impact of the [material] in the water, if there will be some problems with the fishes, as there is with micro plastics" (Case C_Interview, Pos. 34)
		"much more targeted and much, much more careful. [...] Without inserting further mutations that you don't want to have or that have negative consequences" (Case D_Interview, Pos. 6)
	Internal and external Stakeholders	"with regard to potentials and risks, we also have our advisory board, in which we have various experts from business and science who can also make targeted assessments with their expertise" (Case B_Interview, Pos. 29)
		"to increase the public acceptance of genome editing and to better explain the technology to the public" (Case D_Interview, Pos. 31)
		new ideas and projects "are presented to a large group [internally], then they are discussed and [...] we talk a lot about, let's say, what the ethical consequences of this innovation would be" (Case E_Interview, Pos. 20) „respect for people with different opinions" (Case E_Doc2) "internal surveys, where everyone can give their assessment" (Case E_Interview, Pos. 22)

The element of knowledge management was identified in the conceptual framework to fill knowledge gaps that may occur due to new technical requirements in meeting RI criteria, such as a higher ecological sustainability. As this case study was conducted in the biotechnology sector, which is by nature very research intensive, all companies stated that knowledge management – to acquire missing knowledge or competencies – lies in the nature of the firms.
Thus, all firms are familiar with a specific procedure to acquire knowledge which is usually first conducted internally through the individual competencies of the employees, experiments or other research methods (see sub-category *Internal sourcing* in Table 10).
When the knowledge cannot be acquired through internal sources, all firms rely on their industry network, collaboration with other companies or research institutions (see sub-category *External sourcing* in Table 10).

Table 10. Extractions for the Knowledge management element of the framework

Category	Sub-Category	Quotes
Knowledge Management	*Internal sourcing*	"through experiments [...] and of course literature research" (Case A_Interview, Pos. 34)
		"the different competencies of the employees" (Case B_Interview, Pos. 31)
		"the know-how of the employees Without them I could not do these things at all and we have a very loyal workforce and therefore we have the expertise through our employees in the firm" (Case D_Interview, Pos. 35)
		First try to "fill the gaps internally" (Case E_Interview, Pos. 28)
	External sourcing	"through know-how of the partners in collaborative projects" (Case A_Interview, Pos. 34)
		"external cooperation partners" or "new employees [...] are hired specifically" (Case B_Interview, Pos. 31)
		"is really, really important" (Case C_Interview, Pos. 46) "a very extensive network of people helping like laboratories, research institutes, universities, companies that are doing subcontracting" (Case C_Interview, Pos. 46).
		get information through the partners: "What is up to date in Academia right now, and where do we definitely need to make adjustments to remain competitive?" (Case D_Interview, Pos. 11)
		"get advice from fellow companies, maybe do a collaboration with them, and that often works very well. Because the market is big enough [...] that certain technologies or applications or products can also be well shared" (Case E_Interview, Pos. 28)

4.3.3. Outcome

The outcome dimension of the conceptual framework contains the assessment of innovation outcomes and the iterative process of reflecting on the innovation process and outcomes, which is a key element of strategic implementation. According to the definition of RI, innovation outcomes should meet criteria of ethical acceptability, sustainability, and societal desirability.
It can be stated that in general all case firms apply formal criteria for evaluating innovation outcomes. However, they vary in formality, scope and thoroughness. It must be emphasised that only case firm A applies formal criteria of environmental sustainability, social desirability, and ethical acceptability.

Table 11. Extractions for the assessment of innovation outcome element of the framework

Category	Sub-Category	Quotes
Assessment of Innovation outcomes	*Ecological Criteria*	„We ourselves do not make life cycle assessments for our products" (Case A_Interview, Pos. 22) "assess which process is more sustainable" but "without following formal criteria" (Case A_Interview, Pos. 24). "more than 50% [of the projects] do not proceed due to lack of profitability or lack of sustainability" (Case A_Interview, Pos. 55)
		"life cycle assessments" (Case B_Interview, Pos. 27) "Most of the requirements are not difficult for us to meet, because as a still quite young company we have paid attention to sustainable developments and production processes right from the start. We have modern facilities that allow us to produce both efficiently, cost-saving but also sustainable and therefore this is usually no problem for us" (Case B_Interview, Pos. 35).
		"lifecycle assessment […] with a subcontractor" (Case C_Interview, Pos. 36)
		"how many hectares of agricultural land can be saved" (Case D_Doc4)
		"one of the more important indicators certainly is the CO2 footprint" (Case E_Interview, Pos. 30) "the entire manufacturing and supply chain", including emissions in everyday office life and takes measures such as the sourcing from "controlled organic production from sustainably operating suppliers" or the use of green energy and equipping employees with bicycles to get to work (Case E_Doc2).
	Social Criteria	"do not have that" (Case C_Interview, Pos. 40)
		"social acceptance of the technology" (Case D_Interview, Pos. 31)
		"social responsibility" and "what do you contribute back to society" (Case E_Interview, Pos. 30) "changes in corporate communications and language to be inclusive and gender equitable" (Case E_Interview, Pos. 32)
	Ethical Criteria	Statements are required "for projects involving genetically modified material and for pharmaceutical products" (Case A_Interview, Pos. 44) involving animal testing
		"do not have that" (Case C_Interview, Pos. 40)
		"no longer sell their products on Amazon due to the ethical issue of the company's social and working conditions" (Case E_Interview, Pos. 26)

Nevertheless, all case firms apply criteria to assess the environmental sustainability (see sub-category *Ecological Criteria* in Table 11). Therefore, all firms use life cycle assessments and calculate the CO2 footprint, which is often prepared by an external service provider.

Firm A only assesses the innovation outcomes when it is required in a subsidized project. The interviewee highlights that the ecological criteria are so difficult to meet, that half of their projects are not continued due to unprofitability.

Firm B, on the contrary, stated that it is not difficult for them to meet their criteria of ecological sustainability, as they have modern production facilities and processes. Firm C and E emphasize that environmental sustainability does not only concern innovation and production processes, but all processes that take place in the firm.

Formal social criteria are only applied by case firms D and E (see sub-category *Social Criteria* in Table 11). For case firm D, the social acceptance of their technology is a crucial criterion to assess whether the product can be commercialised.

For case firm E, social criteria to evaluate the outcomes of their innovation processes are an important element of their ECG activities, where the element of contribution of the firm to the society is central. Firm C stated that they neither have social criteria nor ethical criteria yet, but plan to implement these soon.
Regarding the assessment by ethical criteria, firm A stated that they are obliged to give statements on ethical criteria when they work on genetically modified enzymes, but only do so when it is required (see sub-category *Ethical Criteria* in Table 11). Firm E stated that they ensure an ethical value chain by evaluating ethical working and sourcing conditions.

Table 12. Extractions for the iterative process element of the framework

Category	Sub-category	Quotes
Iterative process	*Reflection practices*	[We reflect on cooperation projects in a] Final Report that "has to be drawn by regulation in publicly funded projects" (Case A_Interview, Pos. 38)
		"That actually happens all the time in our company. I would say that this is also somewhat due to the young corporate culture that we regularly question things and reassess them" [innovation processes and outcomes] (Case B_Interview, Pos. 37).
		„not only at the end but actually all the time" (Case D_Interview, Pos. 37) "a solution, is not always the final solution, but a solution naturally also raises new questions" (Case D_Interview, Pos. 37)
		"capturing the status quo as a basis for concrete action is essential. Where do we stand now? How can we become even more sustainable, even better?" (Case E_Doc2) "We must also take a self-critical look at ourselves and not simply say: Yes, we are already sustainable. We are making an effort to do this right" (Case E_Interview, Pos. 40)

The last element of the outcome dimension of the conceptual framework is the iterative process, which includes the reflection on the innovation process and its outcomes and adaptations of the strategy according to new learnings or changes in the firm environment.
In this category, firm A again referred to formal requirements of reflection on collaboration after collaboration projects, other forms of reflection cannot be identified in this case (see sub-category *Reflection practices* in Table 12). On the contrary, firms B, D and E point out that the iteration on processes and results happens all the time. Firm B stated that this constant iteration was part of their firm culture. Firm E emphasises, that critical questioning of the status quo and continuous improvement of sustainability is essential and that the firm pursues this with great commitment.
Firm C did not give a concrete statement on iteration, but due to the maturity status of the firm that just received a seed funding, iteration is usually a central element. Additionally, the firm is currently in its (first) formal process of innovation strategy formulation.

4.3.4. Transparency

For the last element of the conceptual framework, which reflects the transparency of the firm throughout all dimensions, three different sub-categories could be identified throughout the cases studied. The first form identified is required transparency, such as the obligation to publish results of publicly funded projects (see sub-category *By regulation* in Table 13). This applies to all case companies that participate in these projects (A, B, D and E). Another case where transparency

regarding innovation processes is required is when the product needs formal approval, such as in the case firm C for cosmetic ingredients. In this case the interviewee argued that a formal approval would generate transparency for the customer without disclosing the asset of their technology.
Generally, firms A, B, C and E stated that some areas of their technology or intellectual property cannot be disclosed as this would have a negative impact on their competitive position (see sub-category *IP protection* in Table 13). Case firm D, on the contrary, stated that they see the know-how of their employees as greatest asset, which allows them to be proactively transparent about their technology (see sub-category *Proactive* in Table 13).
The proactive element of transparency was found in cases B, D and E. These firms see advantages and benefits for their business in being especially transparent, either to increase acceptance of their technology in case D or so that customers can better understand the value chain and are willing to pay premium prices, as in case firm E.

Table 13. Extractions for the Transparency element of the framework

Category	**Sub-category**	**Quotes**
Transparency	*By regulation*	"scientific publications are published in publicly funded projects" (Case A_Interview, Pos. 50)
		[We need to be transparent for the formal approval as a cosmetic ingredient], „This is what we can present to the customers" (Case C_Interview, Pos. 50)
	Proactive	"We are always open to discussions and also try to present ourselves transparently, especially when it comes to the safety of our products and standards." (Case B_Interview, Pos. 41).
		„most of the things we can do relatively transparently as well, because I see the know-how of the firm as the employees anyway" (Case D_Interview, Pos. 35) „to increase the public acceptance of genome editing and to better explain the technology to the public" (Case D_Interview, Pos. 31)
		"crucial advantage in attracting customers that buy natural cosmetics and pay attention to environmental and marine protection" (Case E_Interview, Pos. 34) "spread knowledge about the sea and its wildlife" (Case E_Interview, Pos. 38)
	IP protection	"confidential areas that are not available for public access" (Case A_Interview, Pos. 50)
		"I would say that there is not always a super-transparent insight into the research projects in our pipeline, because this is also part of the core of our core competencies, which we naturally also want to protect" (Case B_Interview, Pos. 41).
		"We do not plan to tell our customers how we are handling the material" (Case C_Interview, Pos. 50)
		"There are a few areas where we say okay, this is now really so specific and so special and perhaps contains important economic applications in the future. We have then patented these" (Case E_Interview, Pos. 38)

4.4. Validation of the conceptual framework for strategic implementation of RI in SMEs

In order to validate the elements of the conceptual framework based on the case study results it can be stated that the majority of the firms are not familiar with the RI concept. Nevertheless, the elements of the conceptual framework were identified in almost every case firm, but with different characteristics and intensities.

Regarding the purpose dimension, all firms are oriented towards solving grand challenges, such as problems of sustainability. Here, some firms just generally work towards more sustainable products and processes, while other firms identified concrete UN SDGs that the firm is committed to addressing. The notions of responsibility were identified both in goals set for the innovation direction (such as tackling climate action) and overall firm strategy (such as providing fair working conditions).

The element of a code of conduct was only identified in two firms (C and A). However, as these two firms are the ones with the highest RI intensity identified among the cases, it is argued that a code of conduct is a suitable instrument to keep the complexity of factors to be considered manageable as RI intensity increases. Regarding the element of mission and vision, it was found that notions of responsibility were recognisable in most statements of the case firms. However, it must be said that due to the typically short and concise formulation of such statements, the possibilities for defining strategic goals for the implementation of RI are limited. Therefore, it is important to fully elaborate on them in the RI code of conduct. These strategic goals including benefits or competitive advantages to be obtained by the implementation of RI practices, were observed in every case. The findings indicate that it is a relevant element of strategic implementation of RI. Thus, it is added in the validated framework (see Fig. 10).

For the dimension of the innovation process, all elements could be identified and validated among the cases studied. Stakeholder involvement is practiced by all firms, primarily within the context of joint research and development projects with other firms, research institutions or customers. The element of anticipation of negative innovation outcomes was not identified in every case but is especially practiced in those cases with more ambitious RI goals. Therefore, this element is also confirmed in the study, although the (democratic) involvement of external stakeholders in the anticipation process – a key element of RI – still has potential for improvement among all case firms.

The element of knowledge management could be identified among all cases studied. Due to the high research intensity of the biotechnology sector, knowledge gaps are not a rare phenomenon, therefore knowledge management is part of the nature of a biotech company.

For the outcome dimension of the framework, it was identified that all firms assess the innovation outcomes according to predefined criteria including ecological sustainability, social desirability, and ethical acceptability. While the sustainability criterion was identified among all cases, the social and ethical criteria were only applied in some cases. This leaves room for further improvement in implementing RI, as these criteria are key elements of the definition of RI. An interesting finding is the use of external service providers to assess the innovation outcomes, a useful approach to provide an unbiased and honest assessment.

It is interesting to note that the two firms with the most ambitious RI strategies (C and E) both also assure responsible innovation outcomes by demanding their value chain participants to also meet ecological, social and ethical standards. As this is found to be highly relevant for achieving responsible innovation outcomes, the assessment of the value chain is suggested to be added to the conceptual framework in the element of assessment of innovation outcomes.

The element of the iterative process of reflecting, learning and improving with responsibility as goal was also identified among four case firms. It was found that this reflective process is aimed at

improving both the corporate strategy (purpose) and the innovation process. Thus, it is also suggested to be seen as crucial element of strategic implementation of RI and confirmed as part of the framework.

The last element of the conceptual framework to be validated is the transparency element, which was also identified among all case firms. It must be emphasised that the biotechnology sector in Germany already sets high regulatory requirements for transparency. Therefore, some firms practice transparency within the requirements, others proactively practice transparency to achieve benefits that come with the transparent communication of responsible values. A limiting factor for transparency identified among several case firms is the disclosure of competitive advantages (e.g., technologies, processes, patents etc.). The revised and validated conceptual framework for strategic implementation of RI in biotechnology SMEs can be found below (see Fig. 10).

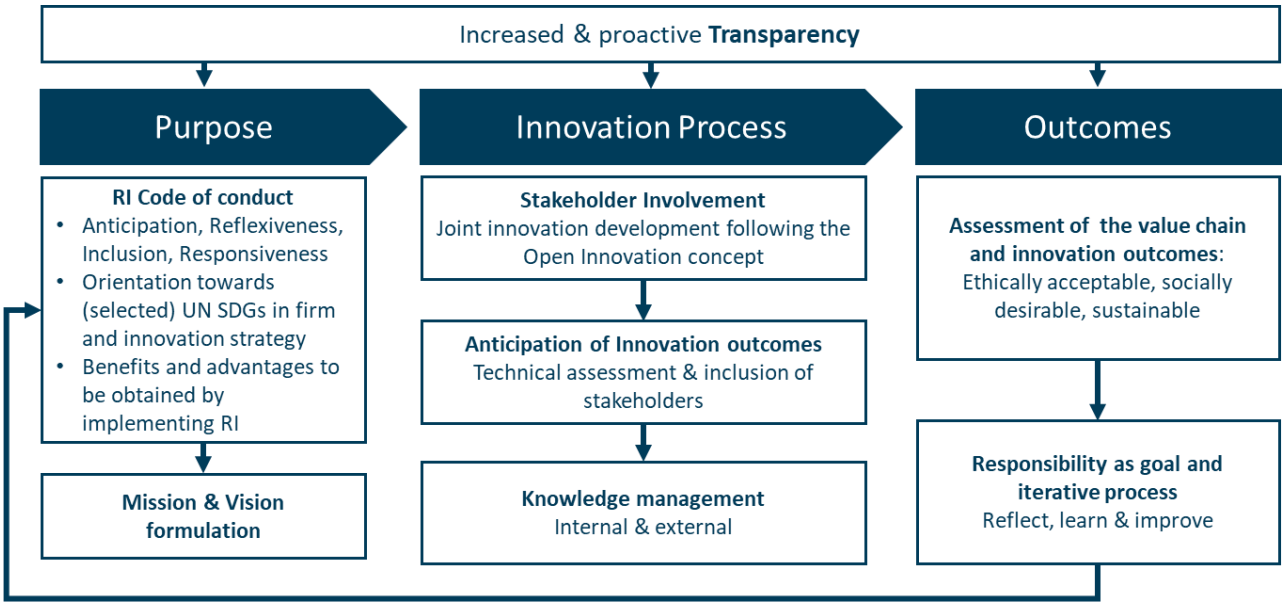

Fig. 10. Revised and validated conceptual framework for strategic implementation of RI in SMEs

In this investigation, the aim was to develop a framework for *strategic* implementation in SMEs. As mentioned in the literature review, four major characteristics of strategy implementation were identified. They include the formulation of a *mission and vision* (1), an *iterative process* of change and control (2), the aim to develop *advantages in a competitive environment* (3) and the definition of these strategies in *policies or action plans* (4). Thus, the proposed framework (see 2.6) is structured according to these elements of strategic implementation in addition to the essential dimensions of RI.

The RI code of conduct represents the policies (4) where the strategies aiming at obtaining advantages in a competitive environment (3) are formulated in. According to the proposed conceptual framework, elements from the RI code of conduct should also be reflected in the mission and vision statement (1). Lastly, the conceptual framework contains the element of Reflection, learning and improving as an iterative element (2). This should enable a process of change and control of the strategies agreed upon in the code of conduct.

In the case study, the strategic element of a formulated mission or vision was identified among all cases, but only four out of five contain responsible elements. An iterative process of reflecting on the innovation outcomes and adjusting the strategy was also identified among all cases, but with varying

regularity and intensity. Thus, it can be suggested that the mission and vision and an iterative process are fundamentally important, but at the same time to a large extent already established procedures in the industry and therefore confirmed as elements of the strategic implementation framework for RI.
The aim to develop advantages in a competitive environment by implementing RI elements was identified in all cases (see sub-category *Competitive advantage* in Table 7). These advantages of meeting higher standards of environmental sustainability, ethical criteria or transparency include better cost structures than the competition, increased profitability, the ability to serve new customer segments and the possibility of receiving subsidies. The findings suggest that the aim at obtaining competitive advantages by strategic implementation of RI is a very central element. It can therefore be assumed that firms do not only pursue responsible activities e.g., based on personal motives, but aim at improving the competitive position. Hence, the formulation of clear benefits and advantages to be obtained by implementing RI is included in the revised conceptual framework for strategic implementation of RI in SMEs, as it was not integrated distinctly enough in the proposed conceptual framework.
Lastly, in the conceptual framework, a code of conduct was suggested to serve as policy or action plan to strategically implement RI in SMEs. This instrument of a code of conduct was identified directly only at case firm E and indirectly at case firm C. A note of caution is due here since only two out of five firms have implemented or plan to implement a code of conduct to formulate RI strategies and guidelines to be followed by the employees in daily business and decision making. Although the number of firms with a code of conduct is in the minority, it is suggested that the suitability of a code of conduct as policy instrument for strategic implementation of RI in SMEs is confirmed.
Case firms C and E indicate a higher level of strategic implementation of RI, as they have set the solution of concrete UN SDGs as a corporate goal and pursue a high level of RI practices in all phases of the innovation process. These findings may indicate that ambitious RI goals and measures can be complex and unmanageable and may require formal agreement to ensure that all employees are aligned with them. Consequently, a code of conduct is suggested to be a suitable element for strategic implementation of RI in SMEs.

To conclude, all framework elements were confirmed in the qualitative study conducted in German biotechnology firms. The fact that the majority of framework could be identified in the business practice of biotechnology SMEs indicates, that the values and practices aligned with the RI concept are widespread in the industry, although the theoretical concept of RI is largely unknown among the case firms. Furthermore, the characteristics of strategic implementation could be validated.
Two additional elements were identified in the study and found to be relevant for strategic implementation of RI: The formulation of strategic goals, including benefits or competitive advantages, to be obtained by the implementation of RI (1) and the assessment of the whole value chain using the criteria of ethical acceptability, social desirability, and ecological sustainability (2).

4.5. Discussion

4.5.1. Dominant profiles of strategic RI implementation

During the analysis of strategic RI implementation of the case study data and the validation of the framework, two dominant profiles were identified. Therefore, it is needed to categorise the case firms regarding their level/intensity of strategic RI implementation. Based on the identification of the individual elements of the RI conceptual framework in the firm and their RI goals set, firm A is categorized low, firms B and D – medium and firms C and E – high (see Table 14). This categorisation allows cautious interpretations to be made of tendencies or profiles that may correlate with the strategic implementation of RI. Two profiles were identified.

Profile of the founders motives

The first dominant profile involves the motivation of the CEO/Founder to develop innovations and the purpose or motivation of establishing the firm in the first place. For firm A, which has a low level of RI integration, the motivations of the founder to establish the firm were stated as a possibility to commercialise research findings and acquire funding for further projects. The motivation to develop innovations seems to be more oriented towards profitability and the securing of the jobs of his/her employees. The founder's motives of firm B could not be assessed.

The founder's motives to establish firm D were driven by scientific excellence and the ability to apply state-of-the-art technology in practice. In the interviews this motivation was confirmed as still up to date. But a secondary motivation seems to be using this state-of-the-art technology to tackle global challenges such as the climate change.

The motivations of the founders of the firms C and E were clearly focussing on solving grand challenges. Firm C was established with the goal to make use of a bio-based waste and by-product to enable circular products. This is anchored in the founder's personal motivation and in the interview the passion for this topic could be clearly recognised.

Firm E was established with the motivation of marine protection. And still, the motivations of the founder to develop innovations are strongly connected to protecting the ocean, spreading knowledge about the fauna and flora, and making sustainable use of the renewable resources of the sea.

In summary, the sample of this study shows that the founders of the firms in the study sample with the most comprehensive strategic implementation of RI have a strong motivation for RI goals and the solution of Grand Challenges. Hence, it can conceivably be hypothesised that there might be a causal relationship between the personal motivation of the founder of SMEs and the strategic implementation of RI in the firm.

Profile of employee involvement

The second dominant profile identified is also based on the categorization of the level/intensity of strategic RI implementation described above. It was observed that the firms with a higher level of strategic RI implementation practice organizational engagement in their innovation processes (e.g., for anticipation of innovation outcomes) and more importantly in strategy development processes. Here, no indications of processes for organizational engagement could be identified in firm A. Firm B stated that employee involvement is practiced, but that decisions are finally made through the management level, which is also due to the size of the firm. Case firm D highlighted that employee involvement is practiced regularly, and that (strategic) decisions are usually made democratically. Firms C and E both also emphasized that employee involvement is a particularly important element of their strategic processes and decisions are also made democratically to ensure that everybody is

aligned on goals and values of the firm. Both firms C and E mentioned workshops with their employees, some of which were conducted with the help of external consultants, to develop the innovation strategy, the selection of the UN SDGs to be pursued or the corporate guidelines (code of conduct).

Table 14. Dominant profiles in strategic implementation of RI in biotechnology SMEs

Intensity of strategic implementation of RI in the firms	**Motivation to establish the firm / develop innovations**	**Employees' involvement in strategy development processes and decision-making**
Low (Firm A)	Profitability	Very low or no involvement
Medium (Firms B and D)	Self-expression via scientific excellence and state-of-the art technology portfolio To tackle global challenges	Regular and mostly democratic decision-making
High (Firms C and E)	To solve the Grand Challenges	Constant and active strategy development, highly democratic decision-making

In summary, the firms with a higher level/intensity of strategic RI implementation involve their employees more actively in strategy development and decision-making processes. This observation could lay a ground for the proposition that there might be a dominant profile of SMEs strategically implementing RI who involve their employees in decision-making and strategy processes.

4.5.2. Theoretical implications

In this section, implications for theory are presented based on the individual aspects of the thesis aim, including strategic implementation theories, the concept of responsible innovation, RI implementation frameworks and the SME context.

As for *strategic implementation research* it was found that all companies pursue RI practices with the specific goal to obtain benefits or competitive advantages. Considerably more work will need to be done to determine which competitive advantages can be gained by strategically implementing RI and to what extend the RI concept is beneficial for that.

Contributing to *Responsible Innovation research* the case study results suggest that the concept is already widely implemented in firms, without knowing the RI concept itself. Further research should focus on determining how different levels/intensities of RI implementation can be further assessed, to enable better comparative analyses of cases to identify further potentials. All dimensions of RI could be identified in the case study. However, anticipation and broad public stakeholder involvement have been less practised. Further studies could show how public stakeholder involvement in the innovation process could be facilitated in practice of SMEs and whether it is compatible with the economic intentions of a company.

Furthermore, this study identified two additional factors relevant for research dealing with *RI implementation frameworks*. A code of conduct for RI as a central element for implementation was identified in existing literature and validated to be suitable in this study. Further research is required to expand on the specific content of such a code of conduct, as this work was limited in this regard. Additional effort could also be placed on the process of formulation of such a code of conduct. In this study, the assessment of the value chain was identified as additional element of RI implementation.

Further studies regarding the role of responsible value chain assessments to ensure responsible innovation outcomes would be worthwhile.
Regarding the *SME context* of this work, two dominant profiles were identified that need to be examined more closely regarding their link to strategic implementation of RI. The first profile to be further explored includes the connection between the level/intensity of strategic implementation of RI in SMEs and the motivation or values of the founder. The second profile identified emphasizes a connection between the level/intensity of strategic implementation of RI in SMEs and the involvement of the employees in strategic processes and decisions. For both dominant profiles identified, studies can be insightful determining a possibility to use this phenomenon as an advantage in RI implementation.

4.5.3. Managerial implications

Besides contributing to further theory building of the applied RI concept, this study also offers managerial implications for SMEs, especially in the biotechnology sector. The results of the study show that many firms have already integrated parts of the RI into their firm, although most are completely unaware of the concept. Therefore, a firm should analyse their status quo when they want to apply the RI concept to see which dimensions still need to be improved.
As the cases have shown, it is possible to align the firm's strategic goals with selected UN SDGs, which gives the firm a broader societal purpose, aligned with the RI concept. In this orientation, the case firms studied see the opportunity to gain a long-term competitive advantage, e.g., by higher profitability through eco-efficiency or the ability to serve customer segments that are willing to pay premium prices for responsible products. In this context, the firms interviewed see it only as a question of time when the RI criteria, such as ecological sustainability will become legally required criteria. Proactive compliance with these criteria is seen by firms as an opportunity to improve their competitive position in the long term. Especially in the German biotechnology sector, the strategic implementation of RI can also enable firms to receive public subsidies that are conditional to certain sustainability activities and criteria.
The main result of this thesis, the validated conceptual framework for strategic implementation of RI in SMEs, can serve as a tool for firms that want to adapt RI in their firm. The code of conduct identified as central element of strategic implementation of RI can help SMEs to agree on RI values and practices in the firm and to make sure that all employees are aligned. The other elements of the framework, including stakeholder involvement, anticipation and knowledge management as well as the assessment of value chain and outcomes, can serve as a structure to support RI practices in the company.
For managers willing to strategically implement RI in their firm, the strategic profiles identified should be considered as they can be an indication of how RI implementation can be successful. Thus, the CEOs/founders of the SMEs should also personally support the RI concept with their motivation and values and democratically include their employees in the strategic implementation process to enable a full commitment of all persons involved.

4.5.4. Limitations and prospects for future research

Being limited to biotechnology firms, the findings of this qualitative study do not allow broad generalization. As the biotechnology sector is R&D intensive, it has specific characteristics and high regulations influencing RI implementation that do not apply in every industry. A prospect for future research would be the validation and further investigation of the findings of this study in a similarly research intensive and highly regulated industry. However, at the current RI research stage, RI literature (Gurzawska et al., 2017; Ladikas et al., 2019) suggests focussing on specific industries to obtain in-depth insight sin order to suggest the most appropriate incentives for strategic RI implementation.

Another limitation of this study is the number of case firms studied. A sample of five firms for the qualitative study cannot fully reflect the biotechnology sector. In addition, only one interview was conducted per firm, which means that, despite the supplementation with secondary data, no comprehensive picture of the case firm can be guaranteed. However, applied methodological procedures comply with the case study literature recommendations (Godin, 2015; Yin, 2003) and thus provide primary indications and allow first exploration of strategic RI implementation. Therefore, future research prospects include a broader, possibly quantitative study to validate the conceptual framework for strategic implementation in SMEs. It should also be ensured that more SMEs of medium size are included in the sample, as the results for the case firm of medium size deviated more frequently.

The testimony of the interviewees must be relied upon, as statements on sustainability and social commitment can often appear euphemistic. A more in-depth study of the case firms with several on-site interviews, which was not possible during the COVID-19 pandemic, could provide a broader picture of the strategic implementation of RI in SMEs in future research projects.

Conclusions

1. **A higher adoption rate of the Responsible Innovation concept in SMEs can help to solve the grand challenges while avoiding causing new problems.**

The awareness for global challenges, such as climate change, is rising globally among industry and consumers. Actions taken by governments put pressure on firms to act more responsible and e.g., reduce emissions. There is a large consensus that innovative solutions are needed to solve these challenges. Unfortunately, several negative examples have shown that innovations can also cause new problems. The concept of Responsible Innovation aims at solving the grand challenges such as the UN SDGs, and achieving ethically acceptable, socially desirable and sustainable innovation outcomes. Unfortunately, the concept is very complex, has so far been mainly related to research and is not specifically developed for application in an industry context. In particular, the implementation of RI in SMEs, the most common form of businesses in Europe, that also develop innovations, were not in the focus of the research. In addition, some publications state that the implementation of Responsible Innovation in business practice can bring (competitive) advantages. Therefore, it should be further investigated how SMEs can strategically integrate the Responsible Innovation concept.

2. **A conceptual framework for strategic implementation of Responsible Innovation in SMEs consists of a RI code of conduct and a mission and vision (purpose), stakeholder involvement, anticipation of innovation outcomes and knowledge management (innovation process), and the assessment of innovation outcomes, as well as an iterative element of reflecting on results and process (outcomes). In addition, transparency was identified as an important element in all RI dimensions.**

In this thesis, RI is understood as a transparent, interactive innovation process aimed at solving grand challenges, such as the UN SDGs, which outcomes are ethically acceptable, socially desirable, sustainable and do not cause new, unintended problems. RI consists of the dimensions of Anticipation, Inclusion, Reflexivity and Responsiveness. The characteristics of strategic implementation in this thesis include strategies aiming at obtaining advantages in a competitive environment defined by policies, or action plans being implemented in an iterative process of change and control. These strategies are integrated into the corporate mission and vision.

Innovation management in SMEs is often not formalized and the strategy is mostly driven by the founder/CEO.

Based on existing frameworks for RI implementation, Purpose, Innovation Process and Outcome were identified as dimensions of strategic implementation of RI.

The key barriers for SMEs to implement RI include that the concept is partially divorced from reality in the business sector, limited financial and human resources of SMEs, the problematic of IP protection in processes of stakeholder involvement and missing customer awareness regarding sustainable or responsible products in some markets. Also, strategic implementation of RI can lead to competitive advantages or benefits for the firm such as a positive effect on the wellbeing, loyalty and trust of the employees, and improve the firm's image and social acceptance towards the outside. In addition, it enhances the relationship with various stakeholders, including customers, suppliers and business partners and investors. Furthermore, the integration of stakeholders can lead to a better product-market fit and promote the discovery of (hidden) customer needs. Lastly, firms in highly regulated markets can benefit from proactive compliance with standards in approval procedures.

The conceptual framework for strategic implementation of RI in SMEs incorporates the characteristics of RI, strategic implementation, innovation implementation in SMEs and the key barriers and competitive advantages connected to strategic RI implementation.
For the purpose dimension, a code of conduct serves as policy document and to tackle the barriers of missing formalised structures for RI and innovation management in SMEs. Together with the element of the mission and vision, it also functions as an element of strategic implementation. For the innovation process dimension, the elements of stakeholder involvement and anticipation act as central elements of the RI concepts. In addition, knowledge management was identified as a relevant element for obtaining missing knowledge, despite limited resources. For the outcome dimension, the assessment of innovation outcomes regarding ethical acceptability, social desirability and sustainability, ensures that innovations are in line with the definition of RI. The element of reflection on innovation process and outcomes serves as the iterative element of strategic implementation. Lastly, transparency was identified as additional element overarching all dimensions of the conceptual framework. It ensures the transparency as key characteristic of RI and helps obtaining competitive advantages through e.g., better company image and social acceptability.

3. **The case study methodology of the thesis is grounded on the integration of scientific literature on strategic implementation, RI literature, RI implementation studies and publications on SME specific barriers and drivers of strategic RI implementation. It is based on the elements of the conceptual framework as indicators that allow to evaluate strategic RI implementation in the cases through semi-structured interviews and secondary data analysis.**

The conceptual framework is grounded on a broad scientific literature review, including strategic implementation literature, RI and RI implementation studies and publications on SME specifics like drivers and barriers of RI implementation.
The case study methodology was chosen in order to assess the strategic RI implementation in the SMEs and allow both theory testing and building. Since firms are often not familiar with the RI concept, the first step is to determine the status quo of strategic RI implementation in the firm. This is made possible by the case study method, which in this case included semi-structured interviews and secondary data analysis collected via desk research. The interview guideline for the semi-structured interviews was based on the elements of the conceptual framework to ensure a systematic validation of the individual elements.
Biotechnology SMEs were selected as the theoretical findings suggest that the advantages to be developed by strategic implementation of RI can be particularly relevant in highly regulated industries. In addition, biotechnology firms are often focused on solving UN SDGs through innovative technologies, which suggests the implementation of the RI concept.

4. **Based on the comparative empirical analysis of the conceptual framework elements among case firms, it could be stated that the elements of a RI code of conduct and a mission and vision (purpose), stakeholder involvement, anticipation of innovation outcomes and knowledge management (innovation process) and the assessment of innovation outcomes, as well as an iterative element of reflecting on results and process (outcomes) and transparency were expressed and are in correspondence with theory. Therefore, it allows to validate the conceptual framework.**
   Two additional significant elements of strategic RI implementation were found and added to the framework, namely the formulation of competitive advantages to be obtained and the assessment of the value chain by RI criteria.

The empirical analysis allowed to prove that the firms practically apply the elements of the conceptual framework for strategic implementation of RI despite different demographic characteristics, firm size (within the SME range), thematic focus within the biotech industry, and maturity level. Therefore, all elements of the conceptual framework could be validated. The least significant elements were the mission and vision, which is limited in terms of integrating responsible values and the element of anticipation, that was practiced intentionally by only a few case firms. In addition, it was observed, that the involvement of stakeholders is mostly limited to the firms' networks and does not involve the broad public. The element of knowledge management was manifested most significantly, presumably as firms in the biotechnology context naturally deal with knowledge gaps.
Two additional significant elements were identified among the case firms that were added to the framework. The first new element is the formulation of strategic goals, including benefits or competitive advantages to be obtained by the implementation of RI, that was suggested to be added to the content of the code of conduct. The second new element identified involves the assessment of the whole value chain by using the criteria of ethical acceptability, social desirability, and ecological sustainability. This element was included into the assessment of innovation outcomes.

5. **Two dominant profiles of strategic RI implementation in SMEs were identified based on the level/intensity of strategic RI implementation within the case firms, including the personal motivation of the founder and the involvement of employees in strategic processes and decision-making.**

The first dominant profile involves the personal values and motivation of the founder of an SME. The findings from the case study suggest that firms with a higher strategic implementation of RI are led by founders whose values and motivation are aligned with those of RI. In the case of this study, the firms with the highest strategic implementation of RI were already established with the purpose of solving a goal of the UN SDGs.
The second dominant profile suggests that firms with a higher level of strategic implementation of RI involve their employees in strategy formulation and decision processes, which are partly carried out democratically to ensure that all employees are aligned behind the goals.

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Appendices

Appendix 1. Interview guideline for semi-structured interviews, English

Indicator		Question	Results
Introduction		Short presentation of the thesis topic and research aim. 1. Are you familiar with the concept of Responsible Innovation? Introduction to the essentials of the Responsible Innovation concept	Determine whether the interviewee / company is aware of the RI concept.
Company Introduction		2. What innovative products have you already developed or are in the pipeline? 3. What is your intention of developing innovations? 3.1. Societal challenges? User needs? Others? 4. How is innovation management/governance formalised or institutionalised?	To put the interview results into context and identify innovation governance in the case company.
Purpose	RI Code of Conduct	5. Are you familiar with the UN SDGs? If so, do you see connections to your business /innovation strategy?	To determine whether a code of conduct for RI could be the right instruments to manifest RI.
	Mission & Vision	6. Do you have a formulated vision & mission statement? 7. Do you engage your employees in strategy formulation and implementation?	
Innovation Process	Stakeholder Involvement	8. How you involve external stakeholders in the innovation process? 8.1. What kind of stakeholders do you involve and how do you choose them? 8.2. What is your purpose of stakeholder involvement?	To determine the level of external stakeholder involvement in the innovation process.
	Anticipation of Innovation outcomes	9. How do you consider possible consequences of the innovation outcomes?	Reveal existing practices for anticipation of innovation outcomes
	Knowledge Management	10. How do you deal with missing knowledge in the innovation process?	Reveal existing practices of knowledge management
Outcome	Assessment of innovation outcomes	11. What are criteria for the assessment of innovation outcomes? 11.1. Social criteria? 11.2. Environmental criteria? 11.3. Ethical criteria?	Identifying existing practices for evaluating innovation outcomes.
	Iterative process	12. How do you reflect on the innovation process and its outcomes?	
Transparency		13. How transparent are your innovation activities to the outside of the firm?	Determine the level of transparency of the activities of the firm.
Ending		Thanks for the interview, information on the further procedure if there are any further questions.	

Appendix 2. Interview guideline for semi-structured interviews, German

Indicator		Question	Results
Introduction		Kurze Darstellung des Themas der Arbeit und des Forschungsziels. 1. Sind Sie mit dem Konzept der Responsible Innovation vertraut? Einführung in die Grundzüge des Konzepts der Responsible Innovation	Determine whether the interviewee / company is aware of the RI concept.
Company Introduction		2. Welche innovativen Produkte haben Sie bereits entwickelt oder sind in der Pipeline? 3. Was ist Ihre Motivation, Innovationen zu entwickeln? a. Gesellschaftliche Herausforderungen? Nutzerbedürfnisse? Andere? 4. Wie ist Innovationsmanagement/Governance formalisiert oder institutionalisiert?	To put the interview results into context and identify innovation governance in the case company.
Purpose	RI Code of Conduct	5. Sind Sie mit den UN-Nachhaltigkeitszielen vertraut? Wenn ja, sehen Sie Verbindungen zu Ihrer Geschäfts-/Innovationsstrategie?	To determine whether a code of conduct for RI could be the right instruments to manifest RI.
	Mission & Vision	6. Haben Sie eine formulierte Unternehmensvision & Mission? 7. Beziehen Sie Ihre Mitarbeiter in die Strategieformulierung und -umsetzung ein?	
Innovation Process	Stakeholder Involvement	8. Wie binden Sie externe Stakeholder in den Innovationsprozess ein? 9. Welche Art von Stakeholdern beziehen Sie ein und wie wählen Sie diese aus? 10. Welchen Zweck verfolgen Sie mit der Einbeziehung von Stakeholdern?	To determine the level of external stakeholder involvement in the innovation process.
	Anticipation of Innovation outcomes	11. Wie berücksichtigen Sie mögliche zukünftige Folgen der Innovationsergebnisse?	Reveal existing practices for anticipation of innovation outcomes
	Knowledge Management	12. Wie gehen Sie mit fehlendem Wissen im Innovationsprozess um?	Reveal existing practices of knowledge management
Outcome	Assessment of innovation outcomes	13. Was sind Kriterien für die Bewertung von Innovationsergebnissen? Soziale Kriterien? Ökologische Kriterien? Ethische Kriterien?	Identifying existing practices for evaluating innovation outcomes.
	Iterative process	14. Wie reflektieren Sie den Innovationsprozess und seine Ergebnisse?	
Transparency		15. Wie transparent sind Ihre Innovationsaktivitäten nach außen hin?	Determine the level of transparency of the activities of the firm.
Ending		Danke für das Gespräch, Informationen zum weiteren Vorgehen, falls es noch Fragen gibt.	