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Responsible innovation and resource-based theory: advancing an antecedent-outcome model for large manufacturing firms through structured literature review

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Abstract

Technological innovations, despite their several benefits, may have drawbacks, thus, they need a control mechanism or directional channel. Responsible innovation (RI) has gained popularity in technology-intensive countries as a way to regulate otherwise uncontrollable and radical technological innovations. However, existing RI research lacks a clear theoretical foundation and has not adequately addressed the commercial and performance aspects of innovative products and firms. The current research proposes an empirically testable model for RI by conducting a structured literature review, focusing on the commercial aspect of innovative products and firms' sustainability performance in the financial, social, and environmental dimensions. The study suggests a link between RI and the resource-based theory of the firm and proposes that RI can be seen as a distinctive competency developed through the firm's resources and capabilities. The model would help enterprises achieve ethical and social acceptability and improve sustainability performance. Metadata examination of 98 articles yielded insights. The findings and future research directions of this study provide new insights for business strategy and policy.

Keywords Firm performance · Sustainability · Responsible innovation · Resource-based view · Absorptive capacity · Business strategy and policy

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Introduction and background

Poverty, starvation, exponential population growth, infectious illnesses, and climate change are among the world's sustainability concerns that require mutual, shared, organized, and communal actions (Scherer & Voegtlin, 2020). This "sustainability" word has become so much vital that it brought the resultant documents of 289,065 in an unfiltered search from the Scopus database. Out of these, 190,791 were research articles from various fields like business and management, engineering, environmental and social sciences, and computer sciences.

These sustainability challenges need a collective and responsible stewardship based on some values and principles, through public engagement and informed discourse to resolve such issues (Buhmann & Fieseler, 2021). In this regard, RI has suddenly gained traction and momentum that even after extreme crises; Europeans believe that sustainable and smart growth can only be achieved with innovation where RI is developing structure and policy for such innovation (Burget et al., 2017; Memon & Ooi, 2021). In short, innovation with responsibility, i.e., "responsible innovation" will be a way of solving both challenges and problems of sustainability (Tan & Yamada, 2018).

Naturally "responsible innovation" feels right as a mood, as an ideal or desire. It has positive, constructive overtones, with implications of trust and integrity, as science and innovation are directed and done towards socially desirable and socially accepted purposes (Nazarko, 2019; Owen et al., 2012). However, both in concept and practice, it lacks definition and clarity: what may that entail? What could it possibly be? When could it be used? Multiple authors have investigated these issues, presenting a paradigm for RI and illustrating some instances of its use.

Stilgoe et al. (2013, p. 1570) offered a broader and clearer definition:

"Responsible innovation means taking care of the future through collective stewardship of science and innovation in the present."

Advancements in science and technology show a narrow point of view about innovation since other kinds of innovation are not determined, i.e., social innovations (Blok, 2021; Blok & Lemmens, 2015). Moreover, commercialization is a crucial phase in the process of innovation (Baregheh et al., 2009; Ferreira et al., 2017). Commercially driven innovation procedures differ from those in the research due to the preference for financial influence. Moreover, the innovator's interest in the business context might be different from the others (i.e., academic researchers). Research and development departments encounter various privacy and public image restrictions (Lubberink et al., 2017a). Hence, the query related to the way to apply RI in the business context yet exists.

In general, many models of RI are available (Burget et al., 2017; Owen, 2014; Wickson & Carew, 2014), including technology assessment and impact model (Ribeiro et al., 2017). The Stilgoe et al. (2013) framework for RI is among the most prevalent models in the RI literature (Burget et al., 2017; Ribeiro et al., 2017), with anticipation, reflexivity, inclusion, and responsiveness as the four

dimensions of their framework. However, these studies have conveyed a limited view of RI and innovation, which focuses solely on scientific and technological advancement while ignoring commercialization. Since commercialization is the final stage of innovation, this mistake appears to be noteworthy (Blok, 2014; Blok & Lemmens, 2015). The idea of RI in the business setting was unfamiliar until Lubberink and colleagues brought it up in 2017. Due to its conceptual overlap with RI, these researchers further broadened the scope of innovation and studied innovation literature from a sociological view. They presented a framework with five dimensions comparable to the one proposed by Stilgoe et al. (2013). Similarly, very limited empirical studies have measured the impact of RI from the commercialization and profitability perspective (See Ko et al., 2020; Lees & Lees, 2018). This study has reviewed various previous RI frameworks/models/studies so as to present a different and novel proposed model. Some of these focus on antecedents (Halme & Korpela, 2014) and dimensions (Adams et al., 2016; Lubberink et al., 2017a; Silva et al., 2018; Guimarães et al., 2023), whereas the others are limited to defining RI for specific industries (Lees & Lees, 2018; Zhongming et al., 2018; Silva et al., 2018; Di Vaio et al., 2022). Various models are summarized with their characteristics and limitations (See Table 1). Each of these models presents a limited picture of the RI's antecedents and outcomes. There is a great need for a model that should present the full picture and comprises of all salient factors, i.e. antecedents, outcomes, moderation, and mediation (all relationships). Furthermore, it should be based on a theory since the above studies have used some theories for antecedents and different ones for outcomes.

The proposed research model addresses these gaps and presents the following: (1) an empirically testable model, having variables and relationships based on resource-based view; (2) antecedents and outcomes of RI in a single model; (3) RI as a distinctive competency of the firm; (4) RI as a source of direct sustainable competitive advantage; (5) absorptive capacity as the dynamic capability of the firm, as moderator; and (6) outcomes as sustainability performance: financial, social, and environmental. Thus, to conclude, the main objective of this research is to present an empirically (quantitatively) testable model comprising of the antecedents and outcomes of RI through the lenses of RBV that should work in dynamic and ever-changing environments.

Overview of resource-based view and responsible innovation

Since the beginning of the 1950s, most researchers of innovation have analyzed this regarding its role in the competitiveness of organizations (Hamel & Prahalad, 1990). Their reasoning is that the resource-based view (RBV) is the essence of competition, and therefore the basis of a firm's success resides in its resources but not in the firm's goods and services (Barney, 1991a, b; Barney et al., 2001, 2011). It follows that the factors giving rise to innovation within a firm can be understood by simply focusing on the resources and the capabilities that the firm possesses (Nason & Wiklund, 2018).

Table 1 Review of various RI frameworks and proposed framework

Framework suggested by	Proposed framework	Key dimensions of the framework	Outcome paths/dimensions	Limitations
Stilgoe et al. (2013)	RI framework	Anticipation, reflection, inclusion, and responsiveness	Four RI dimensions.	Limited to defining RI dimensions.
Halme and Korpela (2014)	Exploring RI for sustainability in SMEs' through resource-based perspective.	Resources as antecedent of RI comprising financial resources, capabilities, social capital, and reputational assets.	Resources and capabilities as antecedents of RI in SMEs.	Limited to the exploration of the resources and capabilities. The outcomes of RI are not discussed.
Lubberink et al. (2017a, b)	RI in the business framework	Anticipation, reflection, responsiveness, inclusion, and knowledge management	Five dimensions of RI; and commercial aspect of RI.	Limited to the commercialization concept of RI through the dimensions already defined by Stilgoe et al. (2013) plus one additional one
Van de Poel et al., (2017)	A conceptual model for RRI in industry	Anticipation, inclusion, reflexiveness, responsiveness, RRI strategy, RRI for competitive advantage, and RRI activities at operational level	RRI and CSR relationship; and focus on RRI strategies at different firm levels.	RRI framework is limited to the plans and activities at the strategic level, operational level, and outcomes as KPIs; and RRI dimensions as antecedents.
Zhongming et al., (2018)	RI Framework for Engineering and Physical Sciences Research Council 2018	Anticipate, reflect, engage, and act	Four RI dimensions for specific industries.	Limited to the presentation of slightly different RI dimensions. Outcomes not discussed.
Silva et al. (2018)	RI in health framework 2018	Population health value, health system value, economic value, organizational value, and environmental value	Health disparities; and value for all stakeholders involved.	Limited for the health sector only. Not based on RBV.
Gonzales-Gemio (2020)	RI framework for SME's	Anticipation, inclusion, reflexiveness, knowledge management, responsiveness, RI strategy, and market structure and moderators	Utilizing RI dimensions through RI strategy—a typical framework with marketing strategies.	Limited to SMEs. A conceptual model that is not practically testable through empirical research. Not based on RBV.

Table 1 (continued)

Framework suggested by	Proposed framework	Key dimensions of the framework	Outcome paths/dimensions	Limitations
Authors (this research)	Proposed framework for large manufacturing firms—RI and firm's sustainability performances through RBV	Anticipation, reflection, inclusion, responsiveness, RI as distinctive competency, resources and capabilities, dynamic capability, and sustainability performances	Resources and capabilities as antecedents of RI; RI as a direct source of SCA as firm's distinctive competency; absorptive capacity as the dynamic capability and moderator between RI and SCA; and outcomes of RI are sustainable financial, social, and environmental performances.	Specifically designed for large manufacturing firms; and requires considerable resources and capabilities to gain distinctive competency of the firm, i.e., RI.

Firm's resources and capabilities

Barney (1991a, b) contended that sustained competitive advantage (SCA) originates from the resources and capabilities that a firm possesses, which should be valuable, rare, non-imitable, and non-substitutable (VRIN). Our research operationalizes resources as presented by Bakar and Ahmad (2010) who divided them into 6 categories which are (1) physical, (2) reputational, (3) organizational, (4) financial, (5) human intellectual, and (6) technological; whereby entrepreneurial orientation has been considered as part of human intellectual resources (Bakar & Ahmad, 2010). However, the researchers define and operationalize capabilities with some variation; for instance, Zafer Acar and Zehir (2009) consider 7 dimensions of business capabilities. These are (1) management capability, (2) production capability, (3) marketing and sales capability, (4) information system capability, (5) learning capability, (6) logistics capability, and (7) external relationship capability. By contrast, Kamasak (2017) categorizes capabilities "as human capital (skills of both managers and employees), networking abilities (external relationships), and business processes such as IT systems, ERP, supply chain, and logistics systems, knowledge sharing through collaborative platforms, and social software."

Responsible innovation

The tagline "be prepared for the dangers connected with growing technology" emphasizes the need for RI in technologically advanced societies, such as those in Europe (Burget et al., 2017; Chatfield et al., 2017). While many organizations find it easy to come up with new ideas, ethical innovation is an area that demands specific attention. In RI, the social functions of new goods, processes, or business models are evaluated. As a result, a responsible approach to innovation requires bringing about change that benefits both society and the environment (Cajaiba-Santana, 2014; Silva et al., 2018). The term RI has been defined in two ways, i.e., administratively and academically. Thus, administratively it is defined as "responsible innovation is a visible, proactive approach in which societal actors and innovators become voluntarily responsive to each other in order to assess the innovation process' (ethical) acceptability, sustainability, and societal desirability (to allow a proper embedding of scientific and technological advances in our society) (Von Schomberg, 2013, p. 39).

However, RI is defined differently by academicians, for instance, "RI is a higher-level responsibility or meta-responsibility aimed at shaping, maintaining, developing, coordinating, and aligning existing, and novel research and innovation-related processes, actors, and duties in order to ensure desirable and acceptable research outcomes" (Stahl, 2013, p. 712).

Dimensions of responsible innovation

As per the review of the literature, various RI dimensions are found. The European Commission described six dimensions as administrative dimensions of RI:

ethics, engagement, science education, gender equality, governance, and open access ("Regulation (EU) No 1291/2013", 2013). The academic authors have presented dissimilar dimensions like actors, norms, and activities (Stahl, 2013) focusing on reality implementable dimensions. Similarly, six other conceptual dimensions have been discussed in the literature: anticipation, responsiveness, reflexivity, inclusion, sustainability, and care (Burget et al., 2017). However, the latter two dimensions, i.e., sustainability and care, have not been widely cited in the literature.

Four different dimensions were deliberated by Stilgoe et al. (2013): anticipation, responsiveness, reflexivity, and inclusion. These dimensions have been widely studied and considered authentic in the literature on RI (Burget et al., 2017; Lees & Lees, 2018; Scherer & Voegtlin, 2020; Zhang et al., 2019) and are considered as most relevant to the RI implementation. Thus, the four dimensions presented by Stilgoe et al. (2013) will be adopted here.

Anticipation Anticipation is about identifying, forecasting/foreseeing the potential hazards and harms caused by some technological innovation. The tools for anticipation may be technology assessment, foresight, vision assessment, and horizon scanning (Stilgoe et al., 2013). This allows the anticipators to understand the future technological dynamics on a timely basis rather than getting too late to suggest a constructive way out for society. Looking at the future well before time would allow us to allocate resources toward responsible and desirable future directions (Memon & Ooi, 2022a).

Inclusion This refers to allowing public groups and members to be part of stakeholder groups to convey their voices on behalf of the public for the ultimate objective of utilizing science and innovation projects for societal benefit (Stilgoe et al., 2013). Scientific innovations would also attract legitimacy by including public groups to take part in its processes. This way, public opinion, involvement, and governance mechanisms may be established to keep scientific innovation within limits for public benefit (Edwards-Schachter et al., 2012). Activities and programs may be arranged like public conferences, dialogues, gatherings, citizen's juries, focus groups, and deliberative polling (Buhmann & Fieseler, 2021).

Reflexivity This refers to the phenomenon of self-evaluation, self-judgment, and accountability of oneself and institution for their activities, assumptions, and commitments for not crossing the defined limits in their conscious as well as written policies and framework (Stilgoe et al., 2013). One should be knowledgeable enough to scrutinize the harmful acts and processes through the self-governing mechanism (Memon & Ooi, 2022b). This leads to one's moral and ethical value-based system supervising science and innovation research and developing an internal governing mechanism, binding the scientists and organizations to observe moral, ethical, and societal responsibilities. Furthermore, the next level of reflexivity comes through the written code of conduct and policies of the organization or a project and plays its role as an external governing mechanism of reflexivity (Brand & Blok, 2019)

Responsiveness The concept of responsiveness emphasizes the combination, inculcation, and implementation of three previously presented approaches of inclusion, anticipation, and reflexivity throughout research and innovation activities while influencing their line of action, course, programs, and relevant policies (Stilgoe et al., 2013). Moreover, it involves taking action in the direction of emerging new knowledge and perspectives as well as the values of various stakeholders and the public (Burget et al., 2017).

Methodology

The present state of academic research on RI was summarized by conducting a structured review of the literature. The publications were retrieved and selected using a method similar to Seuring and Müller (2008), Harland et al. (2006), and Mayring (2003). This method ensures the objectivity, validity, and reliability of the research process. Constructs were compared to previous research, both within and outside of the specific discipline for research validity (Tranfield et al., 2003). To ensure reliability, all steps of the formal analysis were carried out by two researchers. In the following sections, we will explain how we sourced, screened, and analyzed the articles.

Sourcing the articles

Scopus and the Web of Science may be considered the key databases for abstracts as well as references. We did not include Google Scholar because of concerns about data quality (Meho & Yang, 2007; Mongeon & Paul-Hus, 2016). Web of Science allows access to older materials, while Scopus has wider coverage. The Web of Science database's access to earlier materials is not a benefit because our research is focused on a recent phenomenon. Therefore, we concentrated on Scopus as our primary source.

Since the terminology of "responsible research" was first proposed in the sixth framework program in 2002 (Burget et al., 2017), the search includes articles published from 2002 to 2021, with the goal of fostering emerging linkages between ethics and technology throughout the world. Later on, the terminology of "responsible research and innovation" (RRI) was introduced in Europe's 7th framework programme in 2013 to develop society's trust in scientific innovations ("Regulation (EU) No 1291/2013" 2013), but because the term "resource-based view" (RBV) was first coined in 1984 by Wernerfelt (1984), some articles on RBV were selected, published before 2002 due to their high relevance. Furthermore, it was decided to restrict the search to publications that had been published in peer-reviewed journals only in order to maintain a higher standard of content and to make the number of articles picked reasonable. Due to the author team's linguistic constraints, only English materials were included in our review, whereas only journal articles were selected excluding conference papers, books, proceedings, etc. The keywords in

Table 2 Initial search keywords and number of papers retrieved

No	Search keywords	Articles retrieved until December 2021
1	Responsible innovation and social responsibility	
2	Responsible innovation and corporate social responsibility	132
3	Responsible innovation and large firms	55
4	Responsible innovation and CSR	90
5	Responsible innovation and resource based view	18
6	Responsible innovation and RBV	3
7	Responsible innovation and sustainability	389
8	Responsible innovation and financial performance	52
9	Responsible innovation and firm performance	83
10	Responsible innovation and environmental performance	79
11	Responsible innovation and social performance	102
12	Responsible innovation and social sustainability	181
13	Responsible innovation and environmental sustainability	152
14	Responsible innovation and manufacturing firms	23
15	Responsible innovation and sustainable development	351
16	Responsible innovation and climate change	105
17	Responsible innovation and policy	698
18	Responsible innovation and ethics	324
19	Responsible innovation and strategy	566
20	Responsible innovation and business	434
21	Responsible innovation and commercialization	37
	Total retrieved papers	4164
2nd step		
1	Responsible innovation	2486

Table 2 were entered into the search engine "Scopus" as shown and 4164 articles were found in this phase. After removing duplicates, the remaining were 2486.

Articles' screening

The abstracts were downloaded from the Scopus database and used to determine whether or not an item should be included or omitted throughout the screening process. The abstracts of all articles included in the initial sample of 2486 were read. We kept any article that dealt with RI in the context of RBV and firm performance (any possible antecedent/outcome variable was recorded). Two researchers/authors were responsible for the bulk of the analysis. Both researchers independently assessed the abstracts and compared their findings. Inconsistencies in interpretation were handled by debate until consensus was achieved. Articles that remained unresolved were sent to the back of the queue. Both researchers then worked together to

clear the backlog, favoring the inclusion of an item if there was any dispute. Because the RI literature is so extensive and covers so many diverse topics, this more subjective process based on judgment was necessary. As a result, the inclusion/exclusion criteria emphasized on whether or not a work looked to be focusing on RI in an RBV framework at the micro level (firm level). After the screening at this step, there were 879 items left which we considered too many articles to be reviewed for content analysis. Accordingly, strict criteria were designed to decrease the target set of articles. Thus, they were further thoroughly scanned explicitly fixing the criteria of RI in large firms, RBV variables, RI dimensions, firm performance, and sustainability impacts in all aspects whether financially, social, and environmentally.

This third step excluded many articles, leaving behind 98 articles. The large number of unrelated publications is understandable given our broad search keywords, which contained numerous papers that did not explicitly incorporate the RBV theory into the RI perspective. Even very few articles were found that explicitly discuss the relationship between RI and RBV. Our focus was on articles that explicitly focus on the relationship of RI with RBV (Gonzales-Gemio, 2020; Lees & Lees, 2018; Memon & Ooi, 2021). A total of 98 articles were gathered and assessed as the final sample through the use of multiple channels for acquiring the complete papers, i.e., database subscription/access provided to the authors. The structured literature review is depicted in Fig. 1, which shows the process adopted.

Research questions design

The review is focused on a substantial proof study of innovation activities (and related mechanisms) that enhance RI dimensions, i.e., anticipation, reflexivity, inclusion, deliberation, and responsiveness in business contexts, particularly in larger businesses. This step required the extraction and documentation of data from the 98 publications. To reduce subjectivity, the authors (i) double-checked findings and (ii) met regularly to settle any emergent contradictions in their interpretations. Since the research is based on content analysis, therefore we regularly discussed the ambiguities and issues to clarify each of them. Furthermore, we formulated some research questions for the content analysis focusing on the relationship between RI and the various variables included in the RBV to come across an antecedent-outcome model of RI.

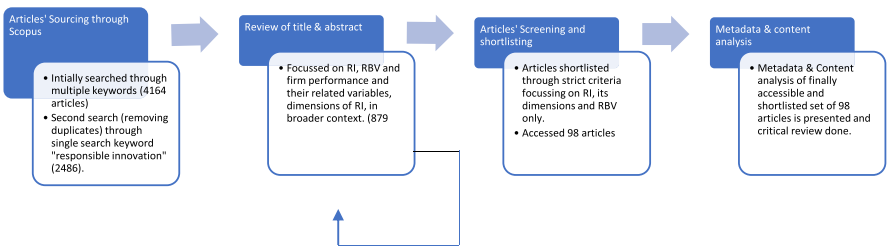

Fig. 1 The methodology followed for the structured literature review

Accordingly, the following review questions were considered during the analysis of studies:

1. How RI can be adopted/implemented in large manufacturing companies?
2. How RBV is related to RI?
3. What are the antecedents of RI? Do resources and capabilities play any role in developing RI?
4. Does RI lead to SCA?
5. What are the consequences of adopting RI practices in larger firms?
6. Do firms get sustainability performances (financial, social and environmental) through SCA achieved as a result of RI?

Research insights

This section summarizes the findings from 98 publications that were objectively chosen from the Scopus and ISI Web of Science databases. We have classified the overall RI and RBV literature in three main categories to establish an antecedent-outcome model of RI. In general, RI along with RBV research has been divided into three major categories. The first category classifies RI and resource-based studies at a broader level discussing the concept of RI and resource-based theory separately, their dimension, and implications at a societal level. This categorization group contains 36 publications. The second main category organizes the existing literature on integrating RI philosophy at the firm level and its implementation. These papers are mostly theoretical. Very few empirical researches were found; however, there were a number of systematic reviews. This category has 40 papers. The third category studies the literature of RI and resource-based theory. The relationship between RI and RBV was found either directly or indirectly. These papers have mainly discussed the concepts of responsibility, innovation, sustainability, and higher firm performance. There were 22 in number. The specific papers used for each of these dimensions and its further break-up of sub-dimensions have been mentioned; however, the most relevant category/dimension was chosen if the paper was relevant to more than one category.

Proposed antecedent-outcome model of responsible innovation

Responsible innovation and resource-based view

Responsible innovation assesses technological innovations with respect to their ethical acceptability, sustainability, and social desirability (Brand & Blok, 2019). Furthermore, there is a strong linkage between RI and RBV since RI involves gathering firm resources and capabilities and utilizes them for the development of socially responsible products. The RBV argues that resources, encompassing tangible and intangible assets, managing skills, and knowledge, serve as the foundation upon which a firm builds its competitive advantage (Barney, 1991a, b; Crook et al., 2008;

Adomako & Nguyen, 2023). Scholten and van der Duin (2015) demonstrate that if stakeholders and consumers collaborate with firms for sustainable, ethical, and socially desirable production systems, SCA is achievable. Accordingly, Lees and Lees (2018) through a qualitative research tested a conceptual model from RBV perspective theorizing RI as an indirect source of gaining competitive advantage. This shows that RI can be a precious resource for attaining SCA.

Hence, it is imperative to understand the relationship between these terms, i.e., resources, capabilities, SCA, and firm performance through RI. In the section below, the analysis is performed on how RI is achieved and what resources and capabilities are required, leading to SCA and higher firm performance (refer to Fig. 2).

The relationship between resources, capabilities, and distinctive competency (i.e. responsible innovation in large manufacturing firms)

Firms gain SCA based on their distinctive competencies that are valuable, rare, inimitable, and non-replaceable (Adams & Lamont, 2003; He et al., 2009). A distinctive competency is something that is developed overtime since it has to be unique, which no one else possesses in the market. This distinction may be based on organizational culture, knowledge and experience, reputation, brand names, coordination system, a network of partners and stakeholders, etc (Leonard-Barton, 1992; Lockett et al., 2008; Peteraf, 1993). Significantly, the attainment of RI as a distinctive competency requires extra resources in terms of human resources, time, and financial capital (Memon & Ooi, 2022b). Since RI engages various stakeholders and focuses on the

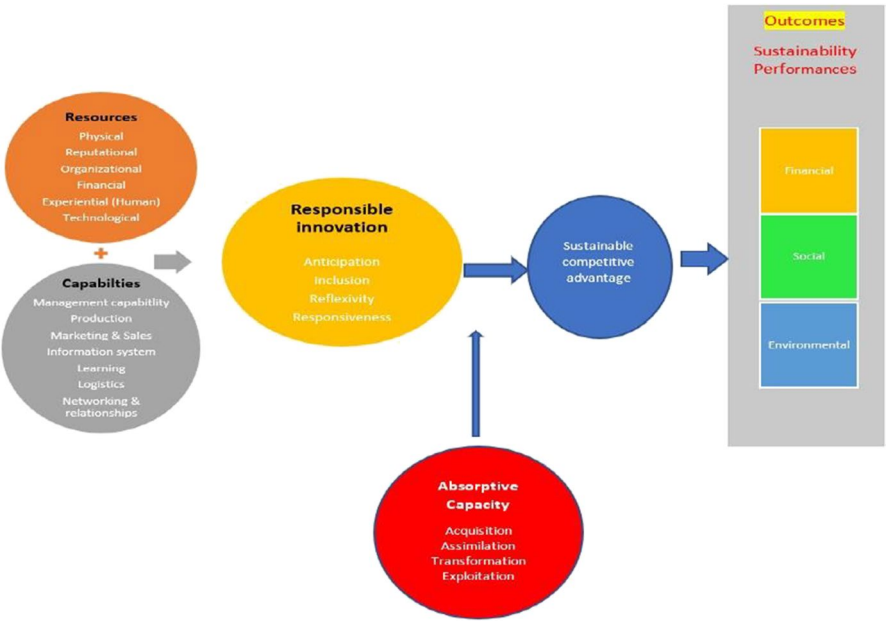

Fig. 2 Proposed antecedent-outcome model of RI, based on RBV

view of social responsibility, identifying appropriate stakeholders, negotiating and considering their views, and maximizing the shareholder's profitability are greater challenges in this regard (Ko et al., 2020). Several academics have now proven that SCA is feasible since stakeholders and customers are more inclined to engage with enterprises that are ethical, sustainable, and have socially desirable production methods and goods (Scholten & van der Duin, 2015). As a result, RI may be a source of SCA while also serving as the firm's distinguishing capability.

RQ3 relates to the issue of what resources and competencies are required to accomplish RI? Anticipation, inclusiveness, reflexivity, and responsiveness are the four dimensions of RI (Zhang et al., 2019). The concept of RI is so powerful and distinct that each of its dimensions can be a unique variable and requires many resources and capabilities. First, anticipation defines actions to ask what is known, what is expected, what is conceivable, and what is possible and represents innovation mechanisms that raise concerns about the goals and objectives, motives, embodiments, trajectories, and consequences of innovation (Stilgoe et al., 2013). Second, reflexivity refers to how the participants in the innovation process socially embody, interact, and respond to the innovation process (Tan & Yamada, 2018). Third, inclusion includes activities that include new voices in the innovation sector, such as going beyond stakeholder participation to the general public (Buhmann & Fieseler, 2021). Fourth, responsiveness refers to the corporate capacity to adjust the reaction of stakeholders and public values and to shifting circumstances (Blok, 2021).

We shall analyze in more detail how RI dimensions play their role in seeking SCA and gaining sustainability performances (financial, social, and environmental) in larger firms.

"Anticipation" and the use of large firm's resources and capabilities Anticipation requires the firm to be long-term oriented to foresee the future technological changes in its industry, evaluate the complexities of innovation before launching, use proper assessment techniques, anticipate innovation opportunities, etc (Ribeiro et al., 2017). In short, it requires being visionary, strategic planning and forecasting, engaging in external market screening and industrial analysis, and deploying technical expertise for assessing and evaluating the impacts of innovation and entrepreneurial capabilities. In anticipating future implications, the two main mechanisms exist (Von Schomberg, 2013). Firstly, all organizations, especially large manufacturing firms, are seeking an increased understanding of the innovation context, such as market trends, legislation, societal trends, technological developments, and regulations (Bartlett, 2009; Gaziulusoy et al., 2013).

Secondly, firms that actively develop a long-term vision still need to align their decision-making processes with RI practices. Almost every firm implements numerous activities to gain a better understanding of the innovation context (Blok, 2021; Lubberink et al., 2017b). Scenario methods are proven helpful to attain this, like the double-flow scenario method, which is beneficial for "understanding the hierarchical irreversible relationships between the environment, society, and economy, issues threatening the sustainability of the society and the implications of these on their organization. And generating normative long-term visions of sustainable societies and developing scenario maps to identify alternative innovation paths between present and these visions" (Gaziulusoy et al., 2013, p. 114). Most businesses have used a

variety of techniques to create more predictable circumstances for change that might lead to innovation. As a result, when enterprises seek to establish a clear correlation between innovation and its benefits, they must develop roadmaps that include various approaches to achieving the intended impacts (Halme & Korpela, 2014).

"Reflexivity" and the use of a large firm's resources and capabilities Reflexivity focuses on the self-accountability system of the organization and organizational capability to bring about necessary changes required for the ethical innovation process (Asante et al., 2014). In the RI process, reflexive innovators play an essential role as they are engaged in the innovative process. Reflexivity can be achieved through formal evaluation, such as when assessing whether the firm is performing according to the goals and objectives set, or firms may try simply to encourage a self-reflective ethos (Chalmers & Balan-Vnuk, 2013). Some studies suggest that RI practices are helpful in reflecting the responsibility to society. The proposed model suggests that this can be achieved through discussing and articulating the reasons for the firm's existence and the firm's responsibilities that come with that.

"Inclusion" and the use of large firm's resources and capabilities Inclusion requires the firm to be open to sharing ideas through the inculcation of a psychologically empowered organizational culture, engagement of various stakeholders, especially the domain experts, users, key external communities, and inculcating of ethical values of innovation as expressed in its objectives and mission (Buhmann & Fieseler, 2021). This requires the organization to create an empowering organizational culture, be learning-oriented, and develop the capacity to absorb and learn from external sources through proper management of various stakeholders throughout the innovation process (Memon, 2014).

It is important that the innovators understand which stakeholders should be involved during the various stages of the innovation process (Dossa & Kaeufer, 2014). If many stakeholders share similar values, the innovation network's goals are more likely to be achieved. According to the proposed framework, inclusive network management is best achieved when all the actors possess the relational, technical, and organizational abilities to bring the innovation to a good end (Harrisson et al., 2012). Only a few articles documented how innovative organizations have engaged with the general public. Most salient studies discussed the activities that innovators mainly engage in with customers and end-users so that they can better respond to their needs (Panda & Sangle, 2020). Usually, the stakeholders are involved in addressing knowledge-related problems, for example, collaboration with industry experts in the recycling of plastics for the development of a sustainable product (Blok, 2021). According to the proposed framework of RI, the main objective is to accomplish and maintain high levels of stakeholder commitment and involvement, where information is shared between the stakeholders and firms (Larson, 2000; Van Mierlo et al., 2020). However, the implementation of the inclusion dimension and getting the benefits of stakeholder engagement requires firms' resources and capabilities; for instance, firms must be able to network and manage stakeholders which

require networking skills (Kamasak, 2017). Furthermore, the firm should have sufficient financial resources to cover the costs of stakeholder involvement. Similarly, relational leadership and experiential resources are also important in managing the firm's stakeholders (Memon & Ooi, 2023).

"Responsiveness" and the use of large firm's resources and capabilities Responsiveness is about focusing on the grand societal challenges of being a socially responsible organization, developing technological innovations that benefit the larger public, and meeting the demands of stakeholders. By putting stakeholders' requirements, opinions, and feedback into practice, responsiveness—prioritizes input from the public and stakeholders and enables firms to become market leaders (Zahoor et al., 2022). Moreover, it stimulates firms to adapt emerging technology and develop products that satisfy future consumer demands. Thus, in order to develop their products, firms need to have the financial resources to continuously look for new materials and technological knowledge (Ludwig & Macnaghten, 2020). While a firm needs physical resources like state-of-the-art machinery and IT infrastructure to create unique products, it also needs human capital—the people who will design and develop these innovative ideas and products—as experience resources (Galbreath & Galvin, 2008; Memon & Ooi, 2022b).

Typical role of resources and capabilities for developing responsible innovation To sum up, firms use physical, financial, experience, reputational, and organizational resources. Physical resources are required to support and sustain an eco-friendly marketing strategy as well as improved business performance since they help in the creation of green products/services, processes, and infrastructure (Bocken et al., 2014; Chang & Sheppard, 2013; Russo & Fouts, 1997). They are particularly important in manufacturing, which is characterized by high energy, water, and solid waste consumption, as well as a wide range of non-durable goods and services (Carmona-Moreno et al., 2004; Leonidou et al., 2013). Financial resources, such as the firm's financial liquidity, working capital, and borrowing capacity, are all important for guaranteeing the stability and effectiveness of being a responsible organization (Leonidou et al., 2017).

Experiential resources are intangible resources and refer to the adequate knowledge of market trends, extensive operational expertise, as well as satisfactory past performance (Kamasak, 2017). These develop through time and give an edge to a firm to quickly grasp the other firms' environmental practices, internal environmental audits, and information from industry advisory boards, etc (Ray et al., 2013). Furthermore, they are major sources of tacit knowledge and improve firm performance in managing operations and manufacturing, e.g. by reducing hazardous environmental wastes. Organizational culture is a one-of-a-kind resource that rivals may find difficult to reproduce due to the restrictions of asset uniqueness and temporal compression diseconomies, (Dierickx & Cool, 1989; Armstrong & Shimizu, 2007; Leiblein, 2011). RI firms need to have open and flexible communication channels, as well as collaborative and quick decision-making processes, so thanks to flat and non-hierarchical organizational structures (Brand & Blok, 2019; Rohrbeck et al., 2013).

A reputational resource, which is an intangible asset, is another business resource (Bakar & Ahmad, 2010). By providing a plethora of knowledge about firms, reputational resources have a beneficial impact on consumers' impressions, attitudes, and viewpoints whereby consumers prefer those firms that are more socially responsible and innovative. Thus, it builds a firm's image as RI firm and increases sales (Jamali et al., 2011; Van de Poel et al., 2020).

Similarly, the firms' capabilities have the ability to transform intangible and tangible resources into distinctive organizational strengths (Teece et al., 1997). These become the main source of performance and SCA (Steenkamp & Kashyap, 2010). Human capital/management capability includes knowledge, skills and abilities, creativity, innovativeness, pro-activeness, and so on (Kamasak, 2017; Randeree, 2006). These enable the firms to think of innovative ideas, and make difficult decisions; for instance, involvement of stakeholders at various stages of product development, how to effectively implement RI practices and programs, and how to tackle environmental and product development issues (Zafer Acar & Zehir, 2009). The networking capability also relates to an organization's capacity to establish and sustain links with external parties, are also associated with the development of firm performance (Dyer & Hatch, 2006; Acquaah, 2012; Weigelt, 2013). Networking skills benefit enterprises enormously by facilitating the transfer of specialized information (know-how), increasing customer and brand loyalty, gaining access to rare resources and restricted markets, and enhancing the firm's learning ability (Chadha, 2011; Kamasak, 2017). Another capability is technological capability. The intricate combination of modern information technology systems with human capital capabilities may significantly increase organizational performance (Hobbs & Scheepers, 2010; Ray et al., 2013; Teece, 1986). Learning capability also has a great connection with human capital and networking capability. This enables the firm to absorb the external knowledge and assimilate it with existing knowledge for innovative product development. These relationships are interdependent and interwoven (Hitt et al., 2000; Zafer Acar & Zehir, 2009).

Likewise, the capabilities of production, marketing, sales, and logistics are interconnected. Firms respond to the demands of stakeholders and societal needs. Stakeholders play a vital role in the innovation process and product development, often resulting in social innovations (Blok et al., 2015; Zawislak et al., 2012). Such innovative products are marketed as socially responsible by emphasizing their sustainable features in advertisements Dreyer et al. (2017). Big data and CRM software can be utilized (Soto-Acosta et al., 2016). Stakeholders contribute to the spread of information through word of mouth (Memon & Ooi, 2021). The goods are then transported using sustainable supply chain and logistics facilities. Salam (2019) discusses various aspects of sustainability in supply chain management, such as sustainable packaging, sustainable warehousing, reverse logistics, and environmental purchasing. Additionally, circular supply chain techniques, blockchain technologies, and robotics can be utilized (Wu et al., 2006; Salam & Dong, 2019). Therefore, these firm capabilities contribute to improved performance and the development of the firm's distinctive competency, i.e., RI.

Thus, from the above-detailed analysis of the concept of RI and its dimensions, as well as their relationships with resources and capabilities, we present the following propositions:

Proposition 1 *Firms' resources* (*physical*, *reputational*, *financial*, *organizational*, *technological and experiential*) *significantly contribute to developing firms' distinctive competency*, *i.e. responsible innovation*.

Proposition 2 *Firms' capabilities* (*management capability*, *production*, *marketing and sales*, *information system*, *learning*, *logistics*, *networking*, *and relationships*) *significantly contribute to developing firms' distinctive competency*, *i.e.*, *responsible innovation*.

Absorptive capacity

Absorptive capacity (ACAP) is one of the widely researched topics over the last 20 years. It has been used in 6 different theoretical areas of research: innovation, learning, dynamic capabilities, knowledge-based view, managerial cognition, and co-evolution (Flatten, Engelen, et al., 2011).

In this study, the term absorptive capacity has been re-conceptualized according to Zahra and George (2002) as a "dynamic capability pertaining to knowledge creation and utilization that enhances a firm's ability to gain and sustain a competitive advantage." These dynamic capabilities are entrenched in organizational processes and become the source of organizational transformation and progression (Kor & Mesko, 2013; Kraaijenbrink et al., 2010).

The first stage of the acquisition process involves discovering and processing new external knowledge related to the organization's activities. Prior experience and prior awareness have a positive effect on this move (Wang & Han, 2011). The second stage, assimilation, reflects the integration, transfer, and understanding of the information gained. The third stage of transformation is about merging current information and new information. Each move employs the skill of the company to build and optimize processes that promote the transfer and internalization of information. The fourth stage, exploitation entails supplying the information for commercial purposes (Flatten, Engelen, et al., 2011).

Firm's absorptive capacity, dynamic capability, and performance—the moderating role of absorptive capacity Lin and Wu (2014) argued that some firms are more successful and gain higher firm performance than others in a similar industry, which have almost similar resources and therefore, the reason behind the higher performance and greater market share is the existence of dynamic capabilities (Teece, 2014). They further explain that these dynamic capabilities can be developed through the firm's absorptive capacity since firms need to develop, integrate, and reconfigure their capabilities to cope with the challenges of dynamic and

technology-intensive environments. External sources' knowledge, expertise, and experience allow the firm to reconfigure or transform existing resources to adapt to the market changes and cope with the rivalry. Therefore, this all depends on the firm absorptive capacity; the greater the firm's capacity, the better performance results will be achieved (Lin & Wu, 2014). Since the absorptive capacity of the firm increases its social and cognitive acceptability through the creation of "value" in the eyes of its stakeholders, therefore, it helps the firm in remaining sustainable and gaining SCA (Ferreira & Fernandes, 2017; Flatten, Greve, & Brettel, 2011; Kale & Rath, 2019; Zahra & George, 2002) which is the justification for research question 4. Thus, we conclude that firms can only achieve SCA and higher performance if they have greater absorptive capacity. Hence, the following proposition is presented:

Proposition 3 *The firm's absorptive capacity significantly strengthens the relationship between responsible innovation and sustainable competitive advantage.*

Responsible innovation, sustainable competitive advantage, and outcomes

Responsible innovation may be a distinguishing competency for a corporation that contributes to gaining SCA, a firm's success, and superior performance. It is widely accepted now that customers and stakeholders are inclined towards socially responsible innovative organizations producing sustainable products (Kale & Rath, 2019). Such responsibly innovative products would pave the way for the firm to achieve and enhance cognitive and social legitimacy, build trust, and a positive image in the eyes of its consumers and stakeholders. RI dimensions play a vital role individually for the firms to gain SCA and sustainability performances (Memon & Ooi, 2022a). Next, we analyze the role of each dimension in improving sustainability performances.

The role of "anticipation" The anticipation dimension leads to technology appraisal and foresight, which may lower the human cost of trial and error while also benefiting from a social learning process among stakeholders and technological innovators. This should lead to (more) societal beneficial products in the end (Von Schomberg, 2013).

Anticipation prompts researchers and organizations to ask "what if?" questions, to consider contingency, what is known, what is likely, what is plausible, and what is possible (Stilgoe et al., 2013). Anticipation involves systematic thinking aimed at increasing resilience while revealing new opportunities for innovation and the shaping of agendas for socially robust risk research. Finally, anticipatory processes need to be well-timed so that they are early enough to be constructive but late enough to be meaningful (Owen et al., 2013a, b).

The role of "inclusion" The inclusion dimension emphasizes multi-stakeholder involvement in RI-projects, which should bring together representatives from industry, civil society, and academia to jointly define a strategy for the responsible development of a specific product within a specific research/innovation field, such as

information and communication technology or nanotechnology. RI should be evident in both the R & D process and the (product) outcomes and requires multi-stakeholder involvement (Von Schomberg, 2013).

The role of "reflexivity" The dimension of reflexivity facilitates the adoption of norms, and even "definitions" are required for responsible progress. The absence of consensus on a definition for nano-particles, for example, makes regulation and suitable labeling requirements difficult, if not impossible. A researcher observes that the use of standards, certifications, and accreditations symbolizes a new style of governance that has steadily replaced and transmuted positive law as a state-produced product with its market equivalent (Mele et al., 2010; Memon & Ooi, 2022a). While this style of governance may be enhanced, we will unavoidably have to utilize it constructively since the flood of things and processes entering the market would be difficult to manage through governmental bodies and agencies alone. Nonetheless, how these criteria are perceived and used is essential (Von Schomberg, 2013).

Our investigation on RI indicates that reflexivity entails monitoring your own acts, obligations, and expectations. It enhances consciousness regarding the limits of one's knowledge and helps one to realize that one's suppositions are not always applicable. The analysis of previous studies has suggested that the firms conduct multiple reflexive activities to help identify their knowledge gaps and the ways to tackle them (Waldron et al., 2022).

The role of "responsiveness" Responsiveness refers to being able to alter the form or way of innovation in response to the values of stakeholders and the large public (Owen et al., 2013a, b). Van de Poel et al. (2020) discovered that in the case of mutual responsiveness among the stakeholders and firm members, both parties want to resolve an issue since their deliberation assists them in understanding the problem and suggesting potential solutions. The responsiveness implies continuous feedback to policymakers from the data supplied by technology assessment, technology foresight, and demonstration projects that might enable a fruitful innovation cycle (Stahl et al., 2017). Procedures for knowledge evaluation should be devised to enable the evaluation of the quality of information used in the policy process, particularly in areas where scientific judgments contradict one another or where significant knowledge gaps exist. Knowledge evaluation may incorporate cost-benefit analysis, as well as environmental and sustainability effect evaluations (Ko et al., 2020).

Sustainability performance as the outcome Researchers argue that sustainability performance, i.e., financial, social, and environmental, can be achieved by organizations, especially at the local level, through the display of care and concern for the society at large as well as the environment (Borchardt et al., 2011; Iranmanesh et al., 2019; Knight & Jenkins, 2009). The study results of (Zhu & Sarkis, 2004), who researched manufacturing firms posit that organizational efforts towards environmental care lead to the organization's sustainability performance. Furthermore, the systematic literature review conducted by Gonzales-Gemio (2020) regarding RI, conveys similar results. Organizations' social responsibility policies may have a

beneficial effect on firm outcomes, even though expected outcomes vary by country and culture; for example, RI can improve an organization's reputation, image, and so on. Additionally, socially responsible businesses that consider environmental and societal problems anticipate superior outcomes, particularly in terms of social and ecological sustainability (López-Gamero et al., 2009; Zhou & Griffiths, 2008). The workers frequently want to work for responsible and safe businesses; also, consumers like to do business with ethical organizations; and suppliers like to do business with moral and ethical companies (Weber, 2008) resulting in increased acceptability and profitability. Golini and Landoni (2014) and Gualandris et al. (2014) examined worldwide manufacturers' social and environmental policies. They discovered that organizations' financial performance increased as a result of their participation in these initiatives. Abdul-Rashid et al. (2017) found that manufacturers who adhere to sustainable practices enhance their sustainability performances.

To conclude, RI dimensions play a vital role in setting a firm's direction and enable it to make efficient and effective use of its resources and capabilities. RI practices, as they entail a stakeholder-centric approach, build the confidence of stakeholders through collective stewardship and mutual involvement for the development of innovative products. Accordingly, such firms who innovate through adopting RI practices become the center of attraction for customers, suppliers, and shareholders. Stakeholders tend to want to identify and associate with such socially responsible firms (Memon & Ooi, 2022a) resulting in greater profitability. This leads the firm to SCA and higher performance. Therefore, we present the following propositions:

Proposition 4 *Responsible innovation* (*distinctive competency*) *leads to sustainable competitive advantage*.

Proposition 5 *Sustainable competitive advantage achieved as a result of RI leads to sustainability performances* (*financial*, *social*, *and environmental*).

Proposition 6 *Sustainable competitive advantage achieved as a result of RI mediates the relationship between responsible innovation and sustainability performances* (*financial*, *social*, *and environmental*).

Research implications and conclusions

The study suggests that RI is a comparatively new and evolving concept, with very limited adoption in the corporate setting. Research in social and sustainable innovation in commercial settings is relatively uncommon. Multiple new ways exist in innovating for sustainability. Through a thorough literature analysis, the current study gives an overview of innovative practices and provides an antecedent-outcome model of RI for large manufacturing organizations. The model is both theoretically sound and practically applicable in large manufacturing organizations. However, it subsumes many resources

and capabilities that may not be available or affordable to SMEs. The uniqueness of this model resides in the fact that, in it, RI is considered as a direct antecedent of SCA. This model is empirically testable. The dynamic capability approach through the use of absorptive capacity is another distinguishing feature of this model (Menguc & Auh, 2006). Furthermore, previous models either presented antecedents or only outcomes of RI, whereas this review consisted of both antecedents and outcomes of RI.

One of the most important research implications is that corporations have had trouble balancing innovation, profit, and shareholders' growing concern about social and ethical responsibility. We posit that RI overcomes all these problems (Memon & Ooi, 2021; Memon & Ooi, 2022b). RI is a deliberate method of stakeholder engagement that views stakeholders as having shared and collective responsibility for the impending creative goods and the entire innovation process (Dreyer et al., 2017). Stakeholder involvement, self-identification, and cognitive acceptance of the firm and its products as socially responsible and ethically acceptable ensure profitability (Lubberink et al., 2017b).

Practically, this study may help managers understand a firm's competitiveness and market success. Decisions on when and where to make investments have important implications for management practice. For example, if intangible resources (such as brands, prestige, know-how, and so on) are the most important predictors of greater RI and business success, then organizations must focus on and invest in their unique resources, rather than on tangible resources (i.e., cash, buildings, and physical infrastructure).

With regard to SMEs, since they have limited resources and capabilities; therefore, the limited version of this model which includes lesser resources and capabilities may be applied (Memon & Ooi, 2022a). Through the use of the dynamic capability approach, the SMEs may reconfigure and realign their limited resources as their specific industry and market competition (Newbert, 2007; Wang & Cavusoglu, 2015). The absorptive capacity can pave their way in achieving this target and may help SMEs to gain SCA through the unique combination of resources and capabilities leading to RI (Memon & Ooi, 2022b).

Limitations and future research

The research has some limitations. First, it reviewed just 98 journal papers in the Scopus database that had any influence. However, given that the search was limited to publications in the fields of business research, economics, social science, environmental science, and technical science, several significant existing works may have been omitted inadvertently. Second, since the methodologies used in this study are not comprehensive or fully objective, researchers are invited to address the research topics in this study using other research approaches. Third, the research presents a model that is only applicable to large manufacturing firms.

Furthermore, there may be some biases in article selection since the selection is based on the authors' judgment and choice. Additionally, it is proposed that future studies empirically evaluate the theoretical model. This paper concludes by stressing future prospects for RI research. The proposed RI model may be tested at any geographical location since it is highly practical and implementable in nature.

Researchers may discover various nuances of the relationship between RI and firm performance in various locations.

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Data availability The data that support the findings of this study are available from the corresponding author upon request.

Declarations

Competing interests The authors declare no competing interests.

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