Review Essay

Governing Responsible Innovation: A Systematic Review Using TCCM Framework

BIMTECH Business Perspectives
1–21

DOI: 10.1177/25819542251366086
bsp.bimtech.ac.in

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Abstract

In the era of rapid technological advancement, there is a pressing need for adopting responsible innovation (RI) practices due to technology's adverse impact on society. RI, being a novel concept, provides innovative solutions for addressing ethical, social, and sustainable development (SD) issues. Organizations, due to intractable societal challenges, resort to RI for creating value for stakeholders and establishing governance mechanisms for achieving SD goals. To attain this, a systematic literature review is conducted with an analysis of 48 research articles obtained from the Scopus database between 2003 and 2024. The study uses the Theory–Characteristics–Context–Methodology review framework along with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The study identifies key theories such as the extended resource-based view, stakeholder theory, and principal-agent theory. Moreover, the study discusses the antecedents' mechanism and its potential outcomes, offering insights to direct enterprises achieve ethical and social integrity with improvement in sustainable performance. Our study contributes to the existing literature and also provides future research directions to expand the available knowledge.

Keywords

Responsible innovation, sustainability, ethics, stakeholder engagement, organization

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Introduction

With the strong emphasis on major grand challenges such as poverty, environmental responsibility, climate crisis, and others, the firms are facing alarming situations which hamper their existence. Economic benefits alone are not adequate, and the responsibility of firms toward society is equally essential. These grand challenges cause socio-ecological damage which needs broad mechanisms and involvement of a variety of stakeholders to successfully overcome these challenges. Realizing these intricacies, the United Nations (UN), a global organization has released their agenda of 2030 where they listed 17 Sustainable Development Goals (SDGs), among them SDG 9 which is "Industry, Innovation, and Infrastructure" and SDG 12 which is about "Responsible Production and Consumption" works on the responsible and innovative nature of firms to achieve sustainability. Following this, the European Commission (EC) has propounded two terms, "Responsible Research and Innovation" (RRI) and "Responsible Innovation" (RI) during the innovation program Horizon 2020 to widen their participation in "Science with and for Society," which addresses both societal and environmental issues (Owen, Pansera et al., 2021). Beginning with the work of von Schomberg (2012) with EC and development of RI framework by Stilgoe et al. (2013) has progressively implemented elements of inclusion, reflexivity, and ethical orientation in innovation practices. In extension to this, Stilgoe also introduces a four-dimensional framework including anticipation, inclusion, responsiveness, and reflexivity, while Burget et al. (2017) added two more dimensions, that is, sustainability and care. In other words, to solve both problems and challenges of sustainability, innovation with responsibility, that is, RI is put forward as a solution (Tan & Yamada, 2018).

Although the concept of RI is not so new, it has its roots in science and technology, where ethical issues such as leakage of information are more serious. Similarly, this interdisciplinary concept gets ignited with the emergence of "grand societal challenges" and "ethical concerns" of technology usage that need to be addressed for societal development and sustainability. According to RI researchers, the innovation mechanism should be highly focused on social and ethical aspects of innovation rather than the economic aspects of innovation. Additionally, innovation dimensions should be employed in the way in which innovations impact privacy, environment, safety, and associated values (Brand & Blok, 2019). Despite a plethora of studies and sufficient definitions on RI, there is still a dearth of knowledge that addresses the applicability of RI in industrial sector and its impact on firm performance. This ambiguity makes firms reluctant to adopt RI practices (Ko et al., 2020). Furthermore, the relationship between RI and a firm's sustainability is also underexplored. However, the previously existing literature specifically centered around the drivers and motivations of RI (Iqbal & Ahmad, 2021). It is only in recent years that RI has started to embark on its journey in the business world, which aims at ensuring economic sustainability and social acceptance of innovation outcomes by enhancing RI capabilities, including increasing productivity and enhancing R&D activities (Wang, 2021). Similarly, many academicians were driven to study RI at industrial level because firms are perceived as the prime source of innovation and employment, having requisite resources that help to address the public issues of sustainability by considering RI

as their social responsibility (Schrempf, 2012). However, another reason to analyze RI is because majority of organizations focus only on economic aspect, and there is little research on ethical, social, and environmental aspects, whereas it is very crucial to understand the numerous ethical principles that are essential to perform and strategize RI practices. In the same vein, businesses are unaware of what and how to do, so that firms can accomplish their RI objectives. Nevertheless, these conditions are not only obstructing large organizations, but other small- and medium-scale enterprises (SMEs) are also dealing with impeding situations. Large enterprises, due to their huge portfolios of resources and capabilities, can easily manage to implement RI, whereas SMEs, due to turbulent external environment, face serious issues (Do & Shipton, 2019). Moving a step ahead, RI is also perceived as a governance mechanism where economic aspects meet the societal progress of the economy (von Schomberg & Blok, 2021). Scholars of innovation have proposed that the process of RI is capable of creating values which are sustainable and mutually desirable, with the joint efforts of both organizations and stakeholders (von Schomberg, 2012). Despite this, there is no clear mechanism which demonstrates what stakeholder engagement actually means to the RI. This reinforces the call for engagement of societal actors or stakeholders in the RI activities of the business contexts.

Although the notion of RI has gained significant attention in management literature, there is still a notable gap in systematically addressing the integration of ethical, societal, and sustainability factors into business and innovation practices in an extensive and coherent manner. In contrast, the existing review articles have explored the aspects of RI but with a narrow scope as they focused on a few geographic countries with restricted number of organizational types or industries. These reviews have primarily concentrated on conceptual analysis, antecedents, and policies for SD (Christofi et al., 2022; Di Vaio et al., 2024; Thapa et al., 2019) or presented a framework particularly for large organizations only (Memon & Ooi, 2023). Additionally, the aforementioned publications provide a scattered analysis. However, clarity regarding the interplay between these dimensions is required, which is demonstrated by the current study that imparts directions for defining and implementing RI. Therefore, to address this gap, the present SLR is highly beneficial as it offers valuable insights in this domain with four main objectives. First, it provides a comprehensive assessment of earlier published articles to understand the evolution of RI over time, by comprehending the several policy frameworks and definitions given by various authors. Second, to identify the ethical and social values that will be used to design practices and processes of RI by implementing different models of normative ethics. The third objective is to highlight the significance of sustainability goals that foster RI, sustainable competitive advantage and eventually sustainable performance, including economic, social, and environmental performance. The fourth objective is to involve stakeholders so that the firm can identify the risks and opportunities for both current and future generations.

Analyzing the importance and contributions of RI in business sector, the present review will promote the knowledge with the involvement of all stakeholders by addressing the following research questions using Theory–Characteristics–Context–Methodology (TCCM) framework:

RQ1 How has the concept of RI developed over time?
RQ2 How do ethical and social considerations play a crucial part in the context of RI?
RQ3 How does RI impact SD of business organizations?
RQ4 What stakeholder engagement does for RI?

The study is divided into different sections. In the first section, the study provides an introduction to the concept; second, the methodology adopted in the review; third, the section discusses the findings of the study; fourth, presents the discussion and conclusion; and the fifth section illustrates the future research agendas.

Methodology

The methodology followed to conduct this review is based on systematic literature review (SLR), which is replicable, transparent, and scientific process. SLR is superior to other methods as it follows detailed analysis and synthesis of studies from designated databases with the aim of minimizing biases, having higher quality and validity of antecedents and outcomes due to its nature of replicability. The step-by-step procedure followed by SLR requires defining its search strategy. In particular, the first step followed here is to select a reputable database for identifying extensive literature relevant to our research topic; the next step followed is to define the search formula with a set of appropriate keywords, which will help to extract the desired results from the selected database for title, abstract, and keywords. Furthermore, the process of screening and selecting the articles is done by following the inclusion and exclusion criteria (Tranfield et al., 2003).

Search Strategy

To present a broader understanding of the existing research on RI and its related concepts, the Scopus database is used as the primary source. Scopus is the highest reviewed and organized abstract and index database providing extensive coverage for variety of stakeholders such as industries, government, and research scholars (Elsevier, 2022). This article presents an extensive review on the subject matter with new research insights and avenues for future research. The review started by running a relevant set of keyword search formulas on titles, abstracts, and subject terms (Christofi et al., 2017). To collect keywords used in existing literature an initial scoping study is conducted related to RI. The keyword search formula was made up of two terms "Responsible Innovation" OR "Responsible Research and Innovation." Since the term RI first emerged in the 2003 US act, the search articles published in the time period from 2003 to 2024 were included in this review. Further inclusion/exclusion criterion was carried out by including manuscripts published in top-ranked journals of the Australian Business Deans Council (ABDC) journal quality list 2022, and also articles screened in the *Journal of Responsible Innovation* were included, and articles written only in the English language were considered, see Table 1. The review focuses on the concepts of RI

Table 1. Distribution of Articles in Leading Journals.

S. No.	Name of the Journal	No. of Articles	ABDC Ranking
1.	*Journal of Responsible Innovation*	22	Not ranked
2.	*Asia Pacific Journal of Management*	4	A
3.	*Business Strategy and the Environment*	4	A
4.	*Learning Organization*	2	C
5.	*Technological Forecasting and Social Change*	3	A
6.	*Science and Public Policy*	2	C
7.	*Journal of Management Studies*	2	A*
8.	*Journal of Cleaner Production*	1	A
9.	*Asian Journal of Business Ethics*	1	C
10.	*Technovation*	1	A
11.	*Creativity and Innovation Management*	1	C
12.	*IEEE Transactions on Engineering Management*	1	A
13.	*Journal of Business Ethics*	1	A
14.	*Business and Professional Ethics Journal*	1	C
15.	*Research Policy*	1	A*
16.	*Philosophy of Management*	1	C
	Total	**48**	

and its importance in industrial sector. Only academic articles were included in the review, and gray literature was excluded to conduct quality research.

The following Boolean research query was used for searching relevant data in Scopus database, which can be copied by other researchers:

TITLE-ABS-KEY (“Responsible Innovation” OR “Responsible Research and Innovation”) AND PUBYEAR > 2002 AND PUBYEAR < 2025 AND (LIMIT-TO(SRCTYPE, “j”)) AND (LIMIT-TO (SUBJAREA, “BUSI”) OR LIMIT-TO (SUBJAREA, “SOCI”)) AND (LIMIT-TO (DOCTYPE, “ar”) OR LIMIT-TO (DOCTYPE, “re”)) AND (LIMIT-TO (LANGUAGE, “English”)) AND (LIMIT-TO (EXACTKEYWORD, “Responsible Innovation”) OR LIMIT-TO (EXACTKEYWORD, “Responsible Research and Innovation”)).

Articles Screening

Figure 1 depicts the PRISMA flow chart. Initially, 1,003 articles were gathered after putting filters; a total of 599 documents were extracted, for which abstract reading was done. Articles having no keywords (RI or RRI) were deleted, and 459 articles were left. Again, assessment was done on the remaining abstracts and studies having no relationship with industrial/business sector or articles concerned with artificial intelligence, medical science, agriculture, and education were omitted. The abstracts selected then were 61, for which again careful examination was done, and after reading full-text articles, 13 articles were found trivial for the review, which were discarded, and we returned to 48 studies as our final sample, which we found suitable for our study.

After an in-depth examination, Figure 2 will show a total of 48 articles published on RI or RRI during the time period between 2013 and 2024 that are

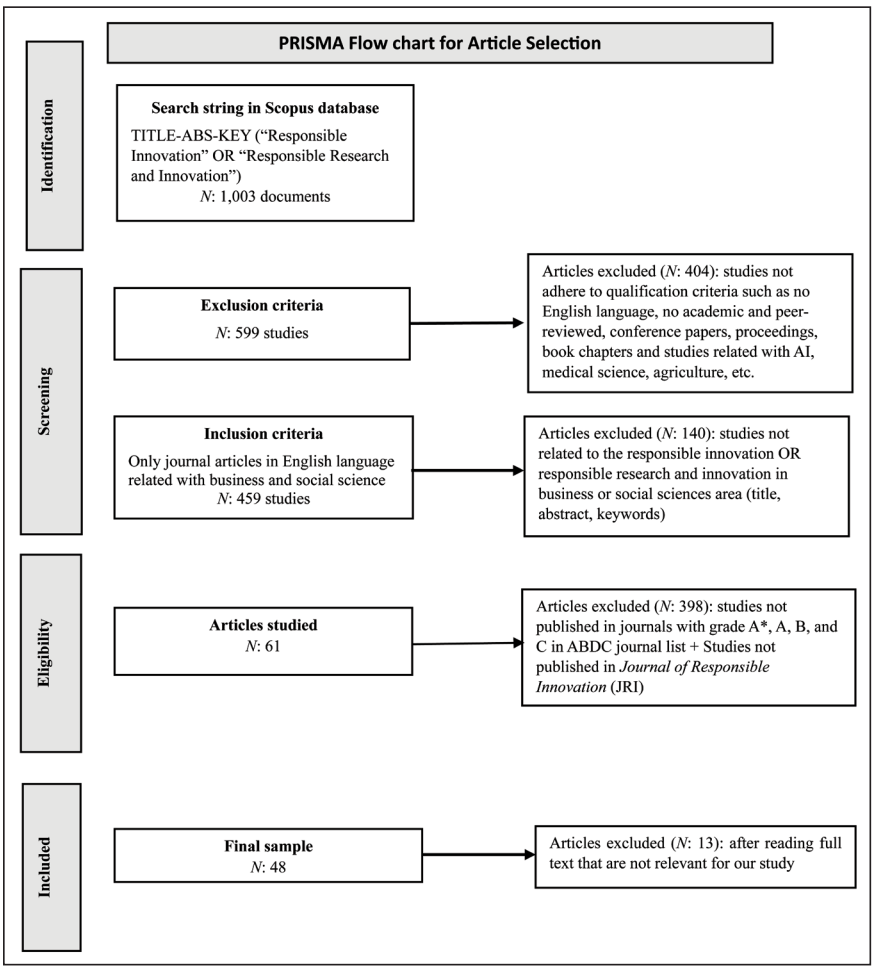

Figure 1. PRISMA Framework.

taken in this review. The majority of articles published in the year 2023 and most of the articles are from the *Journal of Responsible Innovation*. It was only after 2020 when RI gained popularity and an upward trend in the number of publications. The increased interest of academicians/researchers has been found during the last four years, from 2020 to 2024, when 76% of the articles have been published.

Theories, Context, Characteristics, and Methodology Framework-based Analysis of Literature Review

The incorporation of TCCM framework with systematic reviews deepens the analytical scope of study by examining prevailing theories, contextual elements,

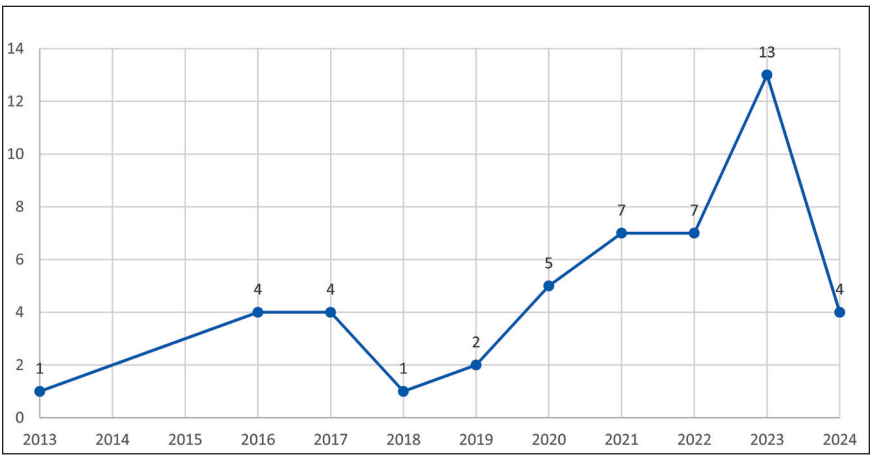

Figure 2. Publications by Each Year.

characteristics, and methods in the existing literature. Thus, expanding on the work of Paul et al. (2021), this study employs TCCM to organize its analysis and suggests directions for future research that tackle identified knowledge gaps.

TCCM: "Theories"

Table 2 specifies the major theories evolved during this review. Many of the studies incorporated in the review adopted dynamic capability theory, which is an extension of resource-based view (RBV). It signifies the use of both internal and external resources/capabilities of the organization and also developing new ones to respond to the changes in the dynamic environment (Teece et al., 1997). Similarly, extended resource-based view highlights that for achieving sustainable business, performance firms not only require to make efficient use of internal resources but also connecting themselves with a wide range of external business networks for exchange of resources and capabilities. Both theories are extended versions of RBV and due to the characteristics of innovativeness and environmental dynamism, and RI requires firms to be fully competent to adjust according to the

Table 2. Evolving Theories in Responsible Innovation Literature.

Theory	Key Publications
Critical theory	Stahl (2024)
Stakeholder theory	Adomako and Tran (2021), Bacq and Aguilera (2022), Cha and Park (2023)
Dynamic capability theory	Adomako and Nguyen (2023), Zhang et al. (2023)
Extended resource-based view	Xie et al. (2024)
Principal-agent theory	Bolz (2017)
Contingency theory	Zhang et al. (2023)

evolving nature of external environment, which is not completely overcome by the static nature of RBV. In addition to this, contingency theory stresses that the effectiveness of firms' strategies depends upon various external factors. RI, on the other hand, emphasizes the ethical and social acceptance of innovation by adjusting its strategies in response to the changing technological and market conditions. Furthermore, the stakeholder theory emphasizes the role of stakeholders in pursuing RI practices for societal betterment. All stakeholders, whether having direct or indirect relations with the organizations contribute to the literature of RI. Stakeholder theory posits that by involving stakeholders in innovation activities, firms can improve the transparency and trust, which eventually leads to sustainable social performance of firms. Critical theory, being a prominent approach in technology aspect of innovation, has its interest in societal phenomena and power dynamics. It asserts that how RI integrates with technology-enabled social events is shaped, accepted, and realized by examining the variety of ideologies and social structures. Next, principal-agent theory, in which science is regarded as an agent of government; however, not only science being the agent for developing new technologies, but society and entrepreneurship should also be regarded as agents for generating innovations that are adopted by all-encompassing stakeholders. Similarly, mechanisms of rewarding incentives are created to encourage more individuals to innovate in socially responsible manner.

TCCM: "Context"

Geographically, most of the research in this review was conducted in developing countries, particularly in Asia, with a large number of regulations and policies. The study took into account the manufacturing sector, specifically SMEs, to explore the sustainable practices, socio-ethical regulations, and stakeholder engagement that affect RI implementation.

TCCM: "Characteristics"

The framework in Figure 3 represents the summary of antecedents and outcomes majorly covered in this systematic review from past literature. Zhang et al. (2023), Adomako and Nguyen (2023), Adomako and Tran (2021), Cha and Park (2023), Zahoor et al. (2024), Lythreatis et al. (2022), and Chatterjee et al. (2021) are few research studies that illustrate how these variables have an impact on RI, particularly in manufacturing sector. As a result of this, firms are able to achieve superior firm performance.

TCCM: "Methods"

Table 3 showcases that the research methods used in the analyzed studies indicate diverse approaches.

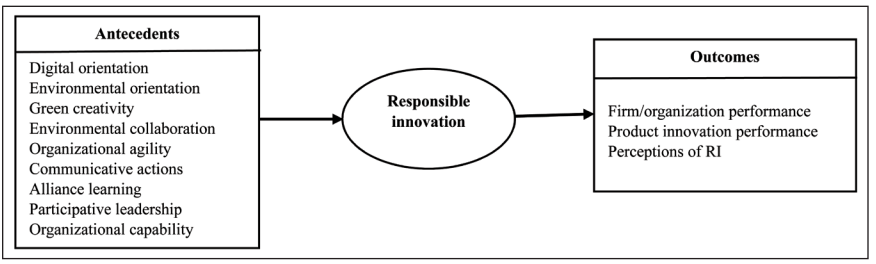

Figure 3. Antecedent-outcome Model.

Table 3. Research Design.

Method	Count
Conceptual/theoretical	28
Survey	8
Case study/interview/reports/ethnographic study	7
Mixed method	1
Literature review	4

Findings

Responsible Innovation

Regarding RQ1, "How the concept of RI developed over time?" it is crucial to study its origin. The history of RRI officially begins with the EC publication, "White Paper on governance," during the Fifth Framework Program (FP5, 1998–2002) stated an intention of uniting democratic institutions with European citizens (EC, 2001). Furthermore, a program titled "Science and Society" was developed during the Sixth Framework Program (FP6, 2002–2006) aims at bringing research and society together (Owen, von Schomberg et al., 2021). The current connotation of RRI first emerged as "responsible development" in the Nanotechnology Research and Development Act (Public Law 108–153 [2]) of the USA in 2003. The idea of responsible development is narrow, as it is concerned more about risk mitigation of negative impacts from different technologies, while the term RRI has a broader implication, which includes innovation policy regime also (Stahl, 2013). RRI also appeared as a policy-driven framework gained prominence due to the urgency of "societal grand challenges," such as economic well-being and growth, unemployment, and others, aiming of aligning them with the values and desires of society (Kuhlmann & Rip, 2014). The following definition is how the EC describes RRI:

> Responsible research and innovation are an approach that anticipates and assesses potential implications and societal expectations with regard to research and innovation, with the aim to foster the design of inclusive and sustainable research and innovation.

> Responsible Research and Innovation (RRI) implies that societal actors (researchers, citizens, policy makers, business, third sector organizations, etc.) work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of society.

Another conference held in Europe in 2012, titled "Responsible Research and Innovation" that support the 8th Framework program labeled "Horizon 2020," characterizing RRI as an intersecting concept and defined RRI as:

> Research and innovation must respond to the needs and ambitions of society, reflect its values and be responsible … our duty as policy makers [is] to shape a governance framework that encourages responsible research and innovation.

In addition to this, the EC sponsored a conference at Rome on November (2014) subtitled: "Science, Innovation and Society – achieving Responsible Research and Innovation," which endeavored to reflect the future of innovation, society and science in Europe (Rome Declaration, 2014). Furthermore, in its program of research funding, "Horizon 2020" EC presents five and sometimes six policy keys: gender, ethics, societal engagement, open access, and science education also including governance as a key with broader RRI approach emphasizing the responsiveness to societal values. Framing of these RRI keys reflected with "Science in Society" and "Science with and for Society" work programs.

However, the most widely used and working definition of RRI is:

> [T]ransparent, 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). (von Schomberg, 2012, p. 9)

In addition to this, Stilgoe et al. (2013) developed a four-dimensional framework including anticipation, reflexivity, inclusion, and responsiveness. Among them, to reduce the potential negative innovation results, anticipation refers to the systematic thinking of various possible innovation results. Reflexivity refers to an enterprise's continuous monitoring of innovation activities and its commitment to innovation processes and products. Inclusion implies that enterprises make use of multi-stakeholder relationships and involve partners in innovation activities. Responsiveness reflects that enterprises adjust their behavior patterns in the innovation process to adapt to the changing environment and the new demands of stakeholders.

However, he defined RI as: "taking care of the future through the collective stewardship of science and innovation."

In addition to this, there exist different perspectives of innovation between legislative and operational level, which makes RI an ambiguous concept that exceed toward weak and strong RI. Weak RI generally applies ethical considerations to the techno-economic innovation, which oriented toward private realm where essence of innovation is missing, that is, serving the public

domain. Strong RI, on the other hand, forms a transformative approach which covers a broader aspect of innovation rather than inadequate techno-economic philosophy and benefiting the public domain by providing a political vision of innovation. Therefore, strong RI does justice to the founding fathers' political ambitions of RI, which they first brought into attention through EU policy circles by uniting itself with the mainstream economic tradition of innovation (von Schomberg & Blok, 2023). Against this backdrop, RI is conceived as a political concept where democratization of innovation procedures, that is, "change the world," eventually interwoven the politics with RI frameworks. Thus, RI appears as a political and more complicated phenomenon, especially for worldwide concerns such as climate change (Stilgoe, 2019).

Ethical and Social Considerations in RI

Concerning RQ2, the technology and science outcomes have certain adverse consequences, which pose the urgency to integrate potential ethical principles into science and technology structures, which directs the RRI framework. However, the second part of the 20th century witnessed the attempts to incorporate normative factors into the governance mechanism of research, science, and innovation (Landeweerd et al., 2015). The 4th European Research Framework Program laid the foundation when Ethical, Legal, and Social Aspects (ELSA) of Research and Innovation originated in 1994 has received an upsurge in attention. Meanwhile, the creation of ELSA labs, which were designed for addressing ethical and social aspects of modern developing technologies, is different from technical laboratory design (Ryan & Blok, 2023). The labs work to ensure human and societal values by taking into consideration approaches such as "pathways to impact" and "societal readiness levels" (Van Veenstra et al., 2021). However, the Horizon 2020 of the EU framework strived to integrate technology assessment with ethical, political, and social legitimacy. It not only defines that what responsibility is, but it also lays down the three normative strategies that form the basis for responsibility in the RI literature (Pellé, 2016). The first strategy is called as proceduralist, which involves procedures/processes of innovation and research that require to be satisfied. It lacks formal rules as it is based on certain conditions that should be followed. To fulfil this, authors put forward five and sometimes four conditions: anticipation, responsiveness, inclusion, reflexivity, and transparency that they have to be complied with (Stahl et al., 2013). The second type is being propounded as consequentialist, which is outcome-oriented, that defines the objectives for RI practices clearly by utilizing utilitarianism approach. The third and last category of moral reasoning is derived from virtues or dispositions of RI actors, systems, and institutions that help to understand the normative dimension of responsibility by focusing on the element of care and virtues. Furthermore, the concept of RI gained momentum with two key definitions, with majority of authors citing work of von Schomberg (2012) and Owen et al. (2013). The definition of von Schomberg takes into account the values and principles that guide the innovation activities, whereas Stilgoe's definition focuses on the idea of collective responsibility of

stakeholders, which barely discusses any values. Therefore, to form a practice-based approach to values, three interwoven attributes were highlighted, such as values as lived realities, values as interactive, and of a dynamic nature with which issues regarding value identification are enquired rather than value justification. Following this, Pellé (2016) identifies a third category by reviewing the literature on RI, which she relates with care and virtue ethics by grinding it with the traditional strategies. Similarly, Pellé and Reber (2015) aligned mainstream traditions of moral philosophy with main responsibility perspectives—deontology, utilitarianism, and aristotelism (virtues) and presented virtue ethics as RI method. Shannon Vallor was the first who advocate the framework of virtue ethics for the deployment and development of technologies, particularly novel technologies that will impact values of humans and society at large (Vallor, 2016). Virtue ethics are believed to be tendencies or qualities which might be developed by individuals through physical workout (Van Tongeren, 2020). There exist two clusters of virtues: "Responsible-side of RI" which includes justice, perspective, anticipation, inclusion and responsiveness, compassion, empathy, and care and "innovation-side of RI" which oriented toward dedication, commitment, collaboration or cooperation, creativity, and others. Furthermore, legitimation is assessed to be a significant element in the normative foundation of RI, where normative ethics require to justify specific values, actions, and norms. For this reason, Cortina (2000) developed civic ethics as a normative legitimation indicator. By integrating a sense of grinding human activity with the complexity of the real world and responsibility for the future, civic ethics tries to overcome the limitations of virtue ethics, which also emphasizes the deontological aspect of normative foundation (Cortina, 2014). Freedom, solidarity, equality, dialogue, and respect are some of the vital values of civic ethics. Another significant framework that is generated during the advancement of RI literature is value sensitive design which aims to analyze the societal values and initiate to explore how RI process might result in both ethical acceptable and socially desirable outcomes (Van den Hoven, 2013). Though this framework is very advantageous in tackling the dynamic global challenges, still there is a lack of correlation with the business administration literature and this disconnection drive toward the development of RI methods that are not practically applied in business processes because the notion of organizational capabilities is missing by which firms are unable to innovate (Friedman et al., 2021). Thus, with the intention of bridging the gap between RI and business management literature, concept of "values" is employed and Value-sensitive Absorptive Capacity approach was developed, having three organizational capabilities. This new capability-based framework integrates knowledge absorption with organizational values in business and values in design. Garst et al. (2019) outline three dimensions of societal values in line with sensitivity; they are Value Receptivity, Value Articulation, and Value Reflexivity.

Sustainable Development and RI

Considering RQ3, the Rio+20 conference held at the United Nations on SD ended in a voluntary declaration by multiple nations to originate a list of 17 SDGs, which

they later amalgamated with Millennium Development Goals framework (United Nations, 2012). The reason behind this commitment emanates from the awareness to guarantee a healthy future for the earth and the people inhabiting it, which requires the attention of mankind living there. Though the concept "Sustainable development" has numerous interpretations, but more specifically, it is conceptualized as the firms' ability to comply with the demands of their stakeholders with the fusion of economic prosperity, societal progress, and environmental protection (Iqbal & Ahamd, 2021). Scholars also intended that it is the social responsibility of the organizations to address the global as well as public issues concerning sustainability because business organizations are key source of innovation, having requisite resources with ability to take action (Schrempf, 2012). Therefore, in order to contribute successfully toward SD, firms need to consider three-dimensional framework of RI that assists business organizations, policy-makers, and practitioners. These dimensions subsumed under three headings—first, "responsibility to avoid harm," which indicates that organizations ensure that their innovation processes, products, and services are responsibly developed and executed without harming the environment and people. Second, "responsibility to do good," which states that in order to enhance environmental sustainability and reduce emissions, organizations should provide with incentives to make their innovation practices more sustainable (Stahl & Sully de Luque, 2014). Third, "governance-responsibility," which facilitates the first and the second dimension of RI by following global governance structures. Therefore, a holistic review of these dimensions assists organizations to foster SD as they have a social responsibility to address the public issues (Schrempf, 2012). In addition to this, RI four-dimensional framework, including anticipation, inclusion, responsiveness, and reflexivity, helps to access sustainable performance. Anticipation enables organizations to evaluate the negative and positive impacts of innovation outcomes and provide solutions to the problems by making firms competent in predicting the extraneous variables' threats and opportunities, which ultimately enhance the sustainable performance and innovation capacities of firms. Reflexivity is concerned with organization's own reflection of values and behaviors that shape innovation practices and procedures to fulfill its goals by representing ethical and social responsibilities, which in return improve the reputation of the firm that ensure long-term sustainability. Inclusion, being another dimension of RI involves a variety of stakeholders who come up with new ideas, inputs and resources to enhance RI activities, whereas responsiveness, the last dimension, responds to the demands and needs of the stakeholders by adjusting the behavior patterns according to stakeholders. However, the participation of stakeholders and responding to their demands helps the firms to fulfill their sustainability goals. Thus, by following this framework, firms perform their social and environmental responsibilities while improving their sustainable performance by simultaneously sustaining economic development (Xie et al., 2024). Similar to above, extant studies highlight the role of corporate sustainability, which affects businesses, both externally through stakeholders' pressure and internally by organization's ethical and cultural values, which in return guarantees that business strategies provide solutions to socio-environmental problems through public open reporting (Opferkuch et al., 2021). According to Hahn et al. (2014),

by incorporating sustainability principles into organization's procedures and systems, corporate sustainability ensures progress while satisfying the stakeholders' demands. As a result, involvement of stakeholders strengthens RI relationship with corporate sustainability and organizational outcomes.

Stakeholder Engagement and RI

With subject to RQ4, the two perspectives of RRI, first, by von Schomberg (2014) who described RI as an interactive and transparent process that brings together sustainability, ethical, and social acceptability of innovation and second, by Engineering and Physical Sciences Research Council (EPSRC, 2016) of UK who defined RI as a process that nurtures innovation and increase opportunities with broader societal impacts that will benefit the public. Both definitions lay stress on the engagement of societal participants in the innovation process. The prominent publication of Valdivia and Guston (2015, pp. 2–3), "Responsible Innovation: A Primer for Policymakers" contended that the conception of RI "seeks to imbue the actors of innovation system a more robust sense of individual and collective responsibility" by following a "governance of innovation where that choice is more consistent with democratic principles." The traditional view where the judgments regarding desirability of innovation and division of labor were governed by consumers or the market, and government has to intervene if these innovations have an adverse impact on society. To overcome this limitation, RI proponents argue to shift this focus from government to innovators, including societal actors. In this vein, Burget et al. (2017) defined RRI as "an essential attempt to govern research and innovation which include all the stakeholders and the public in the preliminary stages of research and development." Similarly, organizations with good stakeholder management mechanisms produce value for their potential stakeholders in a viable and desirable manner that can smoothly succeed their RI objectives. Here, "stakeholder governance" at organizational level is defined as the structural mechanism that directs interactions of organization with numerous stakeholders, including employees, shareholders, consumers, suppliers, etc., by assigning rights, duties, and responsibilities to them (Bridoux & Stoelhorst, 2020). Thus, for establishing a relationship between RI and stakeholder governance, "value-based strategy" study to examine the value generated within the organizations, which later created a model named, value creation and appropriation (Lieberman et al., 2017). This model works on elements such as value creation and value capture for creating value that is appropriate for stakeholders. According to this model, stakeholders have been given two powers, coercive and utilitarian, and by using them they enforce their rules on organizations and dominate the success and failure of activities generating value. Furthermore, the extant literature and the mechanism of stakeholder governance create a relationship between deliberation and inclusion principle of RI and emerged a new concept, that is, "deliberative engagement" with the aim of not just consulting stakeholders and public but also involving and engaging them throughout the innovation process.

Similarly, RI in the business sector applies various approaches where stakeholder engagement and deliberation are most common. Thus, for value creation, distribution and appropriation among various stakeholders, follows three main processes of deliberation: first, it defines a group of stakeholders and their desires by answering what value and for whom it is generated. Second, integration of these stakeholders for achieving RI goals, and last, following the guidelines of fairness and openness, all the procedures of RI are readily accepted by all stakeholders (Bacq & Aguilera, 2022).

Discussion and Conclusion

This study advances both the theoretical and practical knowledge of practitioners by comprehending the concept of RI with other constructs comprises including SD, ethical, social considerations, and stakeholder engagement. The primary objective of this research is to ascertain the strong impact of RI practices at the organizational level, with other domains where evidence is lacking. RI is previously adopted as a policy framework with strong governance mechanisms, which has been later applied in other sectors such as agriculture, cloud computing, medical field, and there is limited adoption in the industrial sector. Thus, with the comprehensive evaluation of conceptual analysis, development, and deployment of RI in all areas, as well as in manufacturing sector, gets worth as organizations are able to understand the value of responsible production and consumption. RI, with its characteristics of an ethical and socially acceptable framework, tries to address the challenges posed by the innovation outcomes with the aim of gathering information that what are the positive and negative consequences of innovations. Virtues and values generated in individuals conjointly in organization's structure highlight a variety of extremely important principles to be adopted for the ethical and normative foundation of RI. Also, the growing interest in positive sustainability outcomes inspired the firms to implement RI strategies at every stage by involving academics, organizations, and government. Sustainability impacts the firm's overall performance by serving the triple bottom line, that is, economic, social, and environmental. Furthermore, with the creation of responsible labs, firms can closely understand the problems associated with emerging technologies, as these labs are considered living labs. RI also analyzes the deliberative engagement of all stakeholders who actively participate in the innovation process and exchange information and resources for creating environmental and social value. With the involvement of the stakeholders' firms, make decisions which are readily acceptable to society.

To conclude, it is important to put stress on the need to design RI strategies and mechanisms that focus on all stages of research and innovation with the involvement of all stakeholders, with a robust system of societal participation mechanisms with the aim of integrating societal actors into organization's innovation process. Similarly, apart from profit maximization, firms must put their efforts toward societal welfare and environmental sustainability.

Practical Implications

The review presents several practical implications for policy-makers and managers. First, by understanding the concept and definition of RI, the study aids managers of manufacturing units on how to design their policies and frameworks for innovating new products, technology, and processes that have no negative consequence on society as well as employees working in the organizations. Second, for articulating innovation strategies, organizations should involve diverse stakeholders *through advisory boards, co-creation sessions or workshops, for the smooth adoption* of sustainable business models that can address the needs of present and future generations. Further, firms along with stakeholders should also collaborate with government to implement action-related programs and policies that *aligns with our finding that stakeholder engagement improves transparency and trust in innovation outcomes*. *Third, this study also assists managers to establish dedicated 'responsible innovation' teams or labs (similar to ELSA labs in Europe) that* offers ethical and social considerations to adopt sustainable processes, green and clean technologies that ensures well-being of workers. By adopting these values managers can proactively addresses the societal and environmental challenges. Last, with the emergence of grand societal challenges, our study highlights the importance of sustainable development where firms should maintain a proper balance between their resource allocation to respond to these challenges in innovative and responsible manner.

Future Research Avenues

The inferences drawn from the current research have a few limitations that present multiple future research opportunities. One major limitation is relying solely on Scopus database for conducting this review, with a limited number of publications focusing on specific fields such as social science, business research, through which some significant research articles may be omitted; thus, it is suggested to consider other databases for more objective choices of articles. While previous research studies relied on resource-based and stakeholder theories, future researchers will explore alternative theoretical perspectives such as systems thinking, quadruple helix, and resource dependency theories that will yield useful insights into the dynamic mechanisms of RI. Similarly, better understanding of the factors influencing the adoption and implementation of RI by various organizations should employ other potential antecedents such as organizational agility, resilience under varying market conditions. Furthermore, despite conducting cross-sectional studies, future scholars may conduct longitudinal studies that shed more light on the domain of RI during a period of time. Future scholars could carry out comparative studies across different industries (manufacturing, technology, healthcare) of different sizes (micro, SMEs, and large) to find differences between their drivers and outcomes. However, to gain more practical and reliable insight, adoption of mixed-methods approach is suggested, including quantitative metrics (sustainability outcomes) and qualitative insights (stakeholders' narratives). In addition to this, researchers can also examine

the governance mechanisms that effectively reflect societal values and may also analyze previous models for adopting virtue and civic ethics that reshape the RI practices and processes. Future researchers can also explore the extent of deployment of co-creation models that combine academics, industry, and government to address SD issues through RI. Finally, RI can also be studied in technology-driven sectors, including artificial intelligence, blockchain, and renewable sector, to implement innovation principles in rapidly evolving fields.

Acknowledgments

Both the authors have contributed equally.

Author Declaration

We here by declare that the submitted manuscript is original and has not been previously published or submitted for publication elsewhere in any form.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

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