



Diving into the uncertainties of open innovation: A systematic review of risks to uncover pertinent typologies and unexplored horizons

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ABSTRACT

The open innovation paradigm has created substantial new opportunities for firms in various sectors. However, scholars have long expressed concern that open innovation also entails a dark side, which can result in value co-destruction. This concern highlights the importance of devoting attention to the perils of pursuing open innovation. Existing scholarship has given due credence to these perils by examining various associated risks and uncertainties. We observe that the extant literature is siloed and unorganized, which impedes future research. Positing that an endeavor to organize existing studies may enhance the pace of research in the area, we attempt to address this gap by reviewing the relevant literature. We thus utilize the systematic literature review approach to identify, synthesize, and critically analyze 80 related research articles. Based on this analysis, we present the bibliometric profile of the extant research and a typology of five risks in open innovation: data-related risks, people-related risks, firm-level risks, outcome risks, and other risks. In addition, we discuss a specific risk management approach for each of the identified risks. Beyond providing a lucid narrative of the extant literature, we also identify unexplored avenues and offer an overarching framework to conceptualize future research potential in the area. From a practical perspective, managers can utilize this framework as a risk assessment tool when engaging in open innovation. In sum, this review—one of the first of its kind—offers a valuable consolidation of the state of the art of open innovation risk research, which can meaningfully advance theory and practice in the area.

1. Introduction

Open innovation has proven useful with firms reporting a variety of positive outcomes, such as enhanced firm performance, innovation performance quality (Greco et al., 2016), and product range and market share (Hochleitner et al., 2017). Furthermore, Chesbrough (2020) hailed open innovation as a way to save costs and time during a crisis, such as the ongoing COVID-19 pandemic. Considering the versatility and

applicability of the concept to various organizational and social settings, it is unsurprising that the research on open innovation continues to draw significant scholarly attention (Lu and Chesbrough, 2021).

Despite the upsides, open innovation can also expose firms to significant risks—both during and after the innovation process (Gebauer et al., 2013; Herzog and Leker, 2010; Marullo et al., 2020; Perotti et al., 2021; Stefan et al., 2022; Alexy and Reitzig, 2012). Engaging in open innovation means that firm boundaries become more permeable.

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Therefore, knowledge and the locus of control of the knowledge flow can sometimes shift outside the firm, which can cause the firm to lose its proprietary knowledge and competitive advantage (Gould, 2012; Rosell et al., 2017). Because the innovative output in open innovation depends on outside conditions, open innovation can also mean losing control of the innovation process and being unable to deliver the innovation at the right time. For instance, the Boeing 787 ‘Dreamliner’ was initially hailed as a benchmark for proper open innovation management—primarily because in developing the aircraft, Boeing favored working with outside suppliers as well as its internal R&D team (Silverthorne, 2009). Over time, however, the project was plagued by delays and structural flaws, which resulted in time overruns and increased costs and created a significant risk at the market stage of the innovation. The cause of the failure can likely be traced to problems in the selection of appropriate contributors (in this case, suppliers) to the open innovation process. This indicates the importance of identifying and addressing risks at every stage of the open innovation process (i.e., ideation–innovation–outcome) rather than attempting to manage it at the end of the project.

Other studies have shown that open innovation risk can manifest in the ideation phase of the innovation itself; at this stage, firms may struggle even to identify the stakeholders that possess the knowledge required (Enkel et al., 2005). Risks can also arise as a result of improper control and protection policies governing the massive amount of data collected from the contributors (Onuchowska and De Vreede, 2017). In fact, no matter the type, the collaborative co-creation of value always entails risks, as summarized by the well-accepted DART (dialogue, access, risk assessment, and transparency) model of co-creation (Pralhalad and Ramaswamy, 2004). DART outlines the steps to promote co-creation in an organization and recommends that firms engage in a thorough risk assessment after establishing dialogue and ensuring access to the relevant contributing stakeholders (Pralhalad and Ramaswamy, 2004). However, similar frameworks summarizing risk assessment and management in open innovation are not available in the extant literature.

Admittedly, a number of studies have already assessed the various types of risks in the open innovation process (e.g. Cao and Song, 2016; Gomes et al., 2021). However, their primary focus has been on the risks that arise from the involvement of a particular class of stakeholders, such as customers, in the process and the ways in which firms manage such risks. With such a limited focus, these studies do not offer generalizable findings that are universally applicable to all open innovation processes (Damali et al., 2020; Hossain and Kauranen, 2016; West and Bogers, 2014). This limited focus has also resulted in deficient knowledge about managing risks, i.e., at the firm level. In addition to remaining confined to the perspective of the stakeholders involved, another limiting dimension of the existing literature is that the scope of research on the risks addressed has remained confined to a single industry at a time (Reichman and Simpson, 2016; Svensson and Hambrick, 2019; Urze et al., 2019). Thus, it has produced only context-dependent risks models.

In sum, although past studies have substantially informed our understanding of open innovation risks and their consequences, the extant literature lacks a general typology of these risks and the best ways to tackle them in the open innovation process. In particular, knowledge of open innovation risk management is scattered across multiple contextual settings. Without adequate typologies or management frameworks for scholars and practitioners, risk assessment and mitigation in open innovation is thus difficult and less comprehensively understood.

Given the undisputable criticality of open innovation in the unfolding inclusive environment and the clear deficiency in knowledge in terms of both coverage and scope, we assert the need for further research to illuminate a broader perspective in the area. We also contend that both scholars and practitioners require particular case-by-case references for handling specific risks in the open innovation process. Specifically, we suggest a need to draw upon the extant literature to formulate a comprehensive framework that typifies and integrates open

innovation risks and risk assessment strategies and thus brings various stakeholders and industries together.

To respond to this need to expand the literature in the area, we address two research questions: *What are the sources of risks in the open innovation process (RQ1)? What are the risk management approaches for each of these risks (RQ2)?* We address these RQs both by conducting a systematic review of the academic literature on open innovation risk and by developing a typology of risks and identifying various ways to address these risks in the open innovation process. We utilize the time-tested systematic literature review (SLR) method to locate, catalogue, and analyze the existing literature on risk in open innovation. Many recent studies have employed this method to present a useful review of the existing literature (Dhir et al., 2020; Madanaguli et al., 2021a,b; Mas-Tur et al., 2020; Talwar et al., 2020). Based on our SLR, we devise a framework to facilitate academics and practitioners’ decision-making regarding risks in open innovation.

We contribute to open innovation research by defining and typifying five major risks in the open innovation process: (a) data-related risks, (b) people-related risks, (c) firm-level risks, (d) outcome risks and (e) other risks. We also summarize the risk management techniques for each of these risks as presented in the extant literature. This exercise allows us to analyze the complex nature of risk, the ways in which different types of risks are intertwined, and the ways in which these risks can impact various stages of innovation. The novelty of our work lies in promoting a more comprehensive understanding of the risks involved in open innovation and in developing a framework that synthesizes the main findings of this review. Our study’s contribution is enhanced by our cognizance of value creation and the firm-level view as a broader narrative. This awareness is consistent with the past literature, which has discussed value creation and the alignment between firms’ open innovation and related business models (Chesbrough et al., 2018; Zhu et al., 2019).

2. Boundary and scope of the review

2.1. Open innovation

As it has evolved as a field of study, open innovation has been described in a variety of ways. A recent review of the academic literature on open innovation (Obradović et al., 2021) summarized various descriptions of the term. In its basic interpretation, open innovation refers to intentionally allowing the inflow and outflow of knowledge to and from a firm to leverage external knowledge in designing value propositions through a distributed—rather than a centralized—innovation process (Chesbrough, 2003; Chesbrough and Bogers, 2014). By including the pecuniary and non-pecuniary benefits that can accrue to various stakeholders, newer definitions have increasingly recognized open innovation as a process of value co-creation whose benefits extend beyond the firm (Chesbrough and Bogers, 2014). Further, the outcomes of the open innovation process are expected to align with the business model of the firm.

To elaborate, open innovation advocates the creation of a distributed innovation system through which firms open their internal innovation processes to external knowledge and skills (Chesbrough, 2003; Chesbrough and Bogers, 2014). In contrast to closed innovation systems, it also advocates expanding the firm’s knowledge search strategy beyond the firm’s boundaries (Laursen and Salter, 2006). In these ways, firms are encouraged to include diverse stakeholders, such as customers (Gomber et al., 2018; Malik and Ahsan, 2019), suppliers (Andreassen et al., 2018), non-governmental organizations (NGOs; Dahan et al., 2010; Prahalad and Ramaswamy, 2000), and even competitors in their value creation strategies (Bez and Chesbrough, 2019). To integrate these stakeholders, firms can deploy a variety of engagement strategies spanning different co-creation events and processes, such as crowd-sourcing (Mustafa and Mohd Adnan, 2017; Rayna and Striukova, 2015).

According to past studies, open innovation comprises three forms: inbound, outbound, and coupled (e.g. Mazzola et al., 2012). The process

of *inbound open innovation* invites various external stakeholders to share information at the ideation and implementation phase; the relevant data are then used in implementing innovation via the R&D process (Lyu et al., 2019; Shi and Zhang, 2018). In contrast, when firms establish ties with external stakeholders to send ideas to the market more quickly and capitalize commercially on available technological opportunities, the innovation process is termed *outbound open innovation* (Mazzola et al., 2012). Coupled open innovation is a combination of the inbound and outbound forms. Offering a more granular understanding of the types of open innovation, Dahlander and Gann (2010) classified sourcing and acquiring as inbound and selling and revealing as outbound open innovation.

Interestingly, Abbate et al.'s (2019) review of the prior literature suggested that more often than not, scholars have used the terms *co-creation* and *open innovation* synonymously to refer to any type of creation that is achieved with any kind of stakeholder. For instance, value co-creation through strategic alliances or collaboration between companies is sometimes considered open innovation (Radnejad and Vredenburg, 2015). More recently, however, a dedicated stream of literature has evolved to investigate innovation through inter-firm alliances and co-opetition as well as the risks and uncertainties associated with these processes (Banerjee and Siebert, 2017; Chen et al., 2021). While the evolution of the literature on innovation and co-creation has fostered academic enrichment of the area, it has also produced myriad fragmented insights. Such is the variety and diversity of the literature that synthesizing it within a single review engenders unnecessary complexities. Therefore, we have opted not to include co-creation in the scope of our review. This decision also enables us to avoid diluting our investigation with the overwhelming number of studies available in the domain. Defining contributors as persons or organizations contributing to the open innovation process from outside the focal firm, we focus our attention on suppliers, NGOs, governments, customers, and other contributors to open innovation. To clearly present the conceptual boundaries and interpretation, we synthesize all key terms, their definitions, and scope in Table 1.

Table 1
Important definitions and scope.

Concept	Scope	Exemplary references
Open Innovation	Open innovation describes the opening of a firm's innovation process to outside knowledge and capabilities. It includes crowdsourcing and co-creating with customers, suppliers, NGOs, and other stakeholders. It does not include B2B R&D alliances.	Obradović et al. (2021); Chesbrough and Bogers (2014); Chesbrough (2003)
Risk	In very rudimentary terms, risk refers to the possibility of an uncertain outcome.	Eduardsen and Marinova (2020); Aven and Renn (2009); Sanders and Hambrick (2007)
Risk in Open Innovation	Risk in open innovation refers to any source of uncertainty in the innovation process, such as a contributor's unwillingness to participate, technical difficulties, or any other issue that can cause unintended outcomes, including the failure to capture proper contributions, the inability to achieve innovation outcomes, the leakage of intellectual property, or even innovation failure.	Onuchowska and De Vreede (2017); Alberti and Pizzurno (2017); Enkel et al. (2005)

2.2. Open innovation risk

Studies have shown that risk is a multi-dimensional concept, which is often specific to the system under study (Haimes, 2009). In extremely rudimentary terms, risk refers to the possibility of an uncertain outcome (Aven and Renn, 2009). However, risk is a complex issue that requires a more comprehensive definition. Thus, risk can be understood as an inherent element of strategic planning, which is caused by a lack of clear foresight about the future implementation of a plan (Eduardsen and Marinova, 2020; Sanders and Hambrick, 2007).

The same is true for innovation. Several studies have recognized that innovation itself is a risky task involving uncertain processes and outcomes (Gomber et al., 2018). Although it can serve as a tool to minimize traditional business risks (Fu et al., 2014), open innovation itself creates risks that can, compared to traditional closed innovation, result in a higher number of unfavorable outcomes, including knowledge leaks, loss of competitive advantage (Linåker and Regnell, 2020; Chaudhary et al., 2022), loss of reputation, and damage to brand image, among others (Cao and Song, 2016). Delving more deeply, risk in open innovation can be defined as any source of uncertainty in the process; these might include a contributor's unwillingness to participate (Enkel et al., 2005) or technical difficulties (Onuchowska and De Vreede, 2017)—with the potential to cause unintended outcomes, such as the failure to capture contributions, the inability to achieve innovation outcomes, the leakage of intellectual property (Alberti and Pizzurno, 2017; Ullrich and Vladova, 2016), or even the failure of innovation. Further, Lu and Chesbrough (2021) show that some open innovation practices, such as network and communities, industry-academia collaboration, and contracting and licensing, exhibit an inverted U-shaped relationship with financial performance. This indicates the existence of risk factors when executing too much open innovation.

In this article, we interpret risk from the perspective of the firm engaging in open innovation as any source of uncertainty that can cause a deviation from the desired outcome (e.g., patent, firm performance, or new product). This implies that any firm engaging in open innovation is our point of reference. We adopt this definition because we seek to provide an actionable risk assessment approach for organizations engaging in open innovation. In other words, we seek to advance a holistic and multi-faceted framework that managers can utilize to monitor their open innovation projects, anticipate risks, and deploy the risk management techniques herein summarized.

3. Method

Consistent with recent studies (Dabić et al., 2021; Makrides et al., 2021; Seth et al., 2020; Kraus et al., 2020a,b), we employed the SLR method to locate, catalogue and analyze the literature on risk in open innovation. The SLR was ideal for our purposes because (a) it provides a reproducible method that ensures a systematic overview of the literature (Kushwah et al., 2019a,b; Kraus et al., 2021), (b) it is well suited for literature reviews with clear guiding research questions (Kaur et al., 2021; Madanaguli et al., 2021a,b; T. M., Kaur et al., 2021), and (c) it is often used in reviews addressing innovations, particularly open innovation (West and Bogers, 2014). We utilized a rigorous five-step process to perform this review: (a) developing the guiding research questions, (b) identifying the keywords, (c) defining the inclusion/exclusion criteria, (d) identifying the relevant literature, and (e) analyzing the literature. Fig. 1 provides an overview of the methodology used.

3.1. Guiding research objectives

The current review aimed to understand the types of risks involved in open innovation as well as the methods by which the literature has suggested addressing them. Our main objective was to propose a conceptual framework for effective risk assessment. Therefore, we were guided by the following research objectives, which align with the

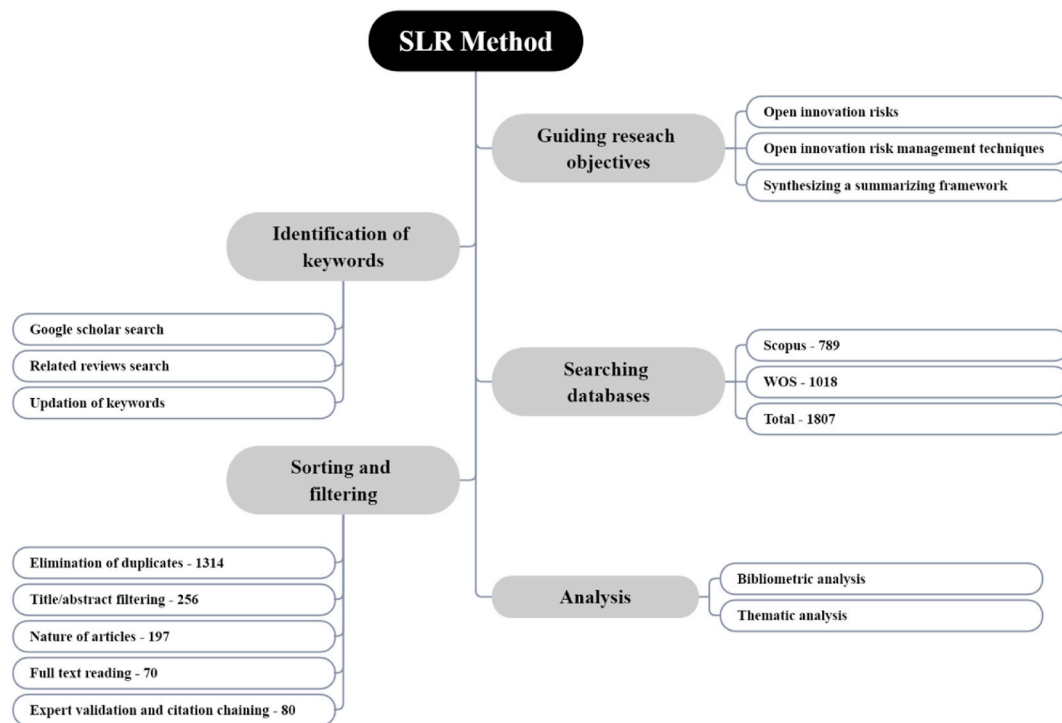


Fig. 1. Systematic literature review methodology.

guiding research questions: *ROI*: To enumerate and classify the various risks in open innovation, *RO2*: To synthesize and consolidate the risk management techniques for each of the risks, and *RO3*: To synthesize a risk assessment and management framework for these risks.

3.2. Identification of keywords

We began with an initial pool of keywords, which we drew from existing reviews on open innovation and risk (Aguinis et al., 2021; Eduardsen and Marinova, 2020; Obradović et al., 2021). As suggested by other reviews in the area, we also selected synonyms for these keywords (Bresciani et al., 2021). These keywords were “open innovation” and “risk*,” “hazard,” and “uncertain*.” Our next aim was to find similar keywords to increase the robustness of the keyword set. Thus, each of the authors searched for the initial keywords in Google Scholar and analyzed the first 100 results (T.M. et al., 2021). We discussed and updated the keywords based on these results and were left with the following keywords: “open innov*,” “co-creat*,” and “value cot*” for open innovation and “risk*,” “hazard,” and “uncertain*” for risk.

3.3. Inclusion and exclusion criteria

Referring to existing literature reviews, we devised extensive inclusion/exclusion criteria for our review (Khanra et al., 2020; Kushwah et al., 2019a,b; Makrides et al., 2021). Our intention was to synthesize various possible risks in the open innovation process by examining the prior empirically validated research. Therefore, we established the following inclusion criteria: (a) only empirical studies, (b) all published studies, (c) studies in journals listed in the *Scopus* and *Web of Science* (WOS) databases, (d) studies published in the English language, and (e) studies addressing relevant firm-level aspects of open innovation related to risks and ways to address them. Simply put, we included a study if it discussed any antecedents for uncertain or unsuccessful outcomes in the context of firms performing open innovation. Similarly, we established the following exclusion criteria: (a) studies that were not published in the English language (to avoid language bias; Kushwah et al., 2019a,b) and (b) editorials, conference proceedings, and any non-peer-reviewed

studies or articles.

3.4. Identification of literature

We searched for the final set of keywords across both *Scopus* and *WOS* over a period of two months, concluding in January 2022. We selected these two databases because they cover a wide variety of journals from multiple research areas, including innovation-related journals. Both databases also provide a robust filtering mechanism, which facilitated the initial selection of relevant articles. After the initial search, we used the filtering tools to exclude (a) studies that were not published in English, (b) conference proceedings, and (c) non-peer-reviewed material. This left a total of 1807 potentially relevant studies; of these, 789 were from *Scopus*, and 1018 were from *WOS*.

After merging the results from both databases and eliminating duplicate studies, we were left with a pool of 1314 potentially relevant articles. We then eliminated irrelevant studies by reading the titles and abstracts. At this stage, each author independently evaluated the relevance of these studies based on the presence of the words “*risk*” or “*uncertainty*” in the abstract or keywords. We did this to minimize any individual-level risks (Madanaguli et al., 2021a,b; Talwar et al., 2020; Kaur et al., 2022). Subsequently, we merged the pool of relevant articles selected by each author and resolved differences in these selections by jointly revisiting and discussing the disputed studies. Following this step, we were left with 256 studies for full-text analysis. After the initial clustering of these studies, we observed that 59 studies did not concentrate on managing risks. Hence, we eliminated them at this stage and proceeded to read the full text of the remaining 197 studies. To ensure robustness and minimize errors in interpretation, three authors from the team read the studies independently and classified them by evaluating their relevance to risks in open innovation. Thereafter, all authors met to discuss the classifications. Because the review’s objective was clearly stated and defined, this stage involved no disagreements. At the same time, independent evaluation followed by joint assessment reduced bias and increased transparency in this phase of the study selection.

As an outcome of this process, we jointly observed three types of

studies in the pool of 197 studies: (a) studies that were not relevant and, despite mentioning risk in the abstract or title, did not discuss it as a main construct (83), (b) studies that investigated open innovation as a way to reduce risk in organizations (40), and (c) studies that investigated the risks involved in open innovation and how to address them (74). Because we were interested in constructing a typology of the risks involved in open innovation, we eliminated studies in the first two categories. This left us with 74 studies for further analysis. As an additional step to ensure the rigor of the study selection process, we sought feedback from three experts with prior research experience on open innovation and open innovation risks. These experts suggested including four additional studies. We also performed a citation chaining search (Kushwah et al., 2019a,b; T. M. and AuthorAnonymous and Joseph, 2020) and identified two new studies, taking the total number of studies for review to 80.

We performed two analyses on the literature. First, we synthesized the studies' bibliographic details, including journal of publication, year of publication, country context investigated, and type of open innovation partner/stakeholder. The summary of this analysis is presented as the bibliometric profile, which depicts the trends in the literature. Second, we performed a detailed qualitative content analysis of the included studies. We present details of the coding process and the thematic analysis in Section 5.

4. Bibliometric profile

In this section, we discuss the bibliometric trends of the studies included in our review. First, regarding publication trends, we observe that the number of studies addressing risk in open innovation has grown steadily and is currently higher than ever before. Considering the popularity of the topic, we expect research on risks in open innovation to further expand in the coming years. Fig. 2 presents the trend of publication since 2004.

Regarding outlets of publication, we observe that technology management journals and marketing journals currently publish the majority of studies on open innovation risk. However, this observation may stem from our self-imposed restriction on the scope of our review, which excluded R&D alliances. Including these studies would have resulted in additional studies from strategic management journals. Further, the prevalence of marketing and information technology-related journals also likely reflects the fact that most of the studies investigated consumers as stakeholders and internet platforms as a means of contribution. Recognizing the role that other stakeholders such as suppliers or NGOs, can play, however, we argue that additional studies are required from these perspectives, which may shift the publication centers to B2B and strategic management-oriented journals. Fig. 3 includes journals with at least two publications on risk in open innovation.

We also examined the research methodology used in the reviewed studies. Most of the studies were explorative case studies, which examined open innovation risks through detailed case studies of one or

two firm or country contexts. Only 21 of the 80 studies used a quantitative methodology to investigate the hypotheses. This indicates a need for additional quantitative investigations inspired by the results of the existing explorative qualitative studies. It is also interesting to note that the majority of the quantitative works adopted the perspective of customers and addressed issues related to trust and privacy (Kristal et al., 2018; Schäper et al., 2021; Wang et al., 2020). Only one study examined the role of empowering leadership in reducing risks associated with open innovation (Naqshbandi et al., 2019). This indicates the need for additional quantitative studies examining other contextual factors, such as supplier contributions to open innovation. Interestingly, none of the included studies employed the experimental method. We believe that such studies are crucial to understanding the behavior of contributors so that decision-makers are aware of possible risks when involving these contributors.

Finally, our analyses sought to capture the country contexts investigated in the studies. In doing so, we hoped to reveal cultural diversity in the available results. It is interesting to note that nine of the reviewed studies examined multicultural online communities; therefore, the country context was not specified. Most studies (five) used the United Kingdom (UK) as the geographical area of interest. Because the cultural background of participants can impact risk and participation in open innovation, we argue that scholars should either perform additional country-specific studies or incorporate controls for country-specific factors.

5. Thematic analysis

We thoroughly evaluated each study for the type of risk mentioned and the strategies discussed to mitigate it. Each of the authors read the shortlisted studies individually and coded them for relevant content (Dhir et al., 2020). We determined the articles' relevance based on our research questions. Each of the studies was thus checked for various types of risk involved in open innovation and for steps firms could take to mitigate these risks. As highlighted in the scope, any issue in the process that led to uncertainty in the outcome was termed a risk to the open innovation process. All identified risks were categorized into first-order codes (Hina et al., 2022; T. M. and AuthorAnonymous and Joseph, 2020). The first-order codes—generated and presented independently by each co-author—were merged into meaningful second-order (sub-themes) and third-order categories (themes) to typify various risks and their corresponding risk management approaches. Coding conflicts were resolved using a voting technique. One of the authors was designated as the leader of this process and possessed a veto in case of a tie. The analysis yielded a typology of the risks involved in open innovation.

To facilitate the comprehension and organization of our results, we clustered these risks into five types: (a) data-related risk, (b) people-related risks, (c) firm-level risks, (d) outcome risks and (e) other risks. It is important to understand that using this typology does not imply that the risks are independent of one another; rather, all risks are interdependent and can aggravate one another or co-exist simultaneously.

5.1. Data-related risks

At present, open innovation is almost always enabled by digital technology. Scholarly attention to this phenomenon has also grown, and studies have increasingly investigated country-independent online communities rather than country-specific samples (Hutter et al., 2015; Lee et al., 2018; Schäper et al., 2021). Digital technology has enabled businesses to collect and harness large amounts of data (or "big data") from their customers (Khanra et al., 2020). Therefore, the technology required for co-creation with stakeholders and the data collected through these online platforms is intertwined. However, the convenience of these inexpensive data transfers also entails undesirable privacy and data validity risks (Dhagarra et al., 2020). We term this cluster

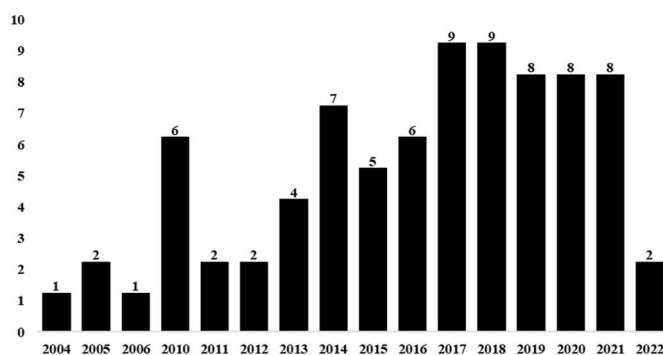


Fig. 2. Time trend of publications.

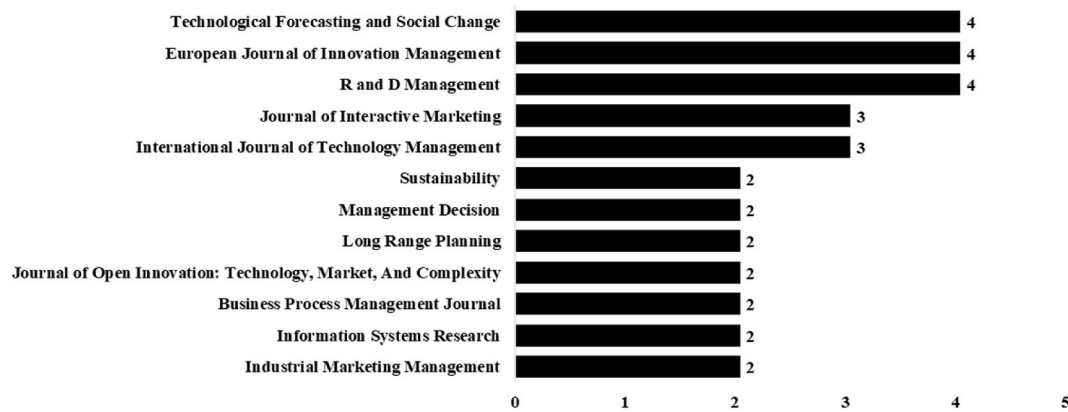


Fig. 3. Prominent sources of publications.

of risks as data-driven risks or simply “data risks.” Data risks occur due to the ways data are collected from contributors and subsequently used inside the organization (Enkel et al., 2009). We identify three sub-categories of risks associated with the main theme: (a) privacy risks, (b) data distortion, and (c) other technical risks.

(a) Data Privacy Risks

The information systems literature has linked privacy concerns about service to a lack of trust and use-avoidance behavior (Dhagarra et al., 2020; Shah et al., 2021; Shirazi et al., 2021; Wu et al., 2012). Digital data acquisition methods are vulnerable to a variety of privacy risks (Pool et al., 2020; Shah et al., 2021). Because open innovation contribution systems are often online and require users to voluntarily surrender information, the extant literature on open innovation has noted similar risks (Adamik and Nowicki, 2019). Privacy concerns about the participation system can lead to trust issues, which exhibit a direct negative relationship with brand value co-creation (Wang et al., 2020). Privacy concerns involving open innovation arise due to the possible leakage of private information that has been voluntarily shared by contributors (Onuchowska and De Vreede, 2017). However, studies investigating the risk of privacy violations have concentrated primarily on the customer as a contributing stakeholder (Enkel et al., 2009; Shirazi et al., 2021). Although this has drawn greater attention to methods for safeguarding consumers’ data, our knowledge on privacy concerns in the case of contributors such as suppliers is limited and represents an interesting future research direction. For instance, the current research does not address the ways in which firms can work with suppliers to co-create interfaces and data management systems to ensure fair access and security. In the absence of such discussions, research is likely to overlook this important issue, especially in the era of digital servitization and business ecosystem creation (Kamalaldin et al., 2020; Reim et al., 2015).

(b) Data Distortion

Data distortion risks occur when data collected from customers are translated poorly from the collection point to the point where the data serve as an input to the innovation process (Enkel et al., 2005). This unreliability of data may be due to intentional or unintentional discrepancies between what is expected and what is extracted from the contributor (Onuchowska and De Vreede, 2017). Because it can direct the process towards failure, data distortion is a serious risk in the pre-ideation and ideation stages of innovation (Enkel et al., 2005). Further, this risk is more prevalent in situations where firms seek contributions from customers or the general public—for example, through bounty hunting or similar competitions. In their investigation of such competitions, Onuchowska and De Vreede (2017) showed that

participants intentionally spread false information among other participants either to enhance their own gains or to impede the efforts of other participants. They also observed the prevalence of self-promotion during such events, which, in turn, promoted the creation of content irrelevant to the open innovation project. The same study also identified prank activity as a concern, whereby malicious contributors may play pranks on other contributors and thus distort the data collected (Onuchowska and De Vreede, 2017).

(c) Technical Risks

Other technical risks occur primarily due to the poor quality of technical systems. Efforts to gain unintended access via hacking or to take a system offline via a distributed denial of service (DDoS) attack are among the key concerns (Onuchowska and De Vreede, 2017). Because these attacks commonly aim to gain access to data, they are likely to entail complex relationships between technical risks and privacy concerns and, therefore, reduce stakeholders’ trust in the process (Valdez-Juárez et al., 2021). Poorly designed systems with bugs and errors can also significantly hinder value co-creation. Malar et al. (2019) showed that banking customers’ intentions to co-create were severely impacted by bugs in the banking system they were using. For instance, a weak system open to hacking may be particularly vulnerable to data leaks and distortion and is thus less likely to attract contributors.

(d) Addressing Data Risks

Firms can manage data risks by implementing various proactive controls—for example, by installing firewalls, monitoring the history of network flows, deploying multiple ISPs, and creating recovery plans in case of successful attacks (Onuchowska and De Vreede, 2017). Because data distortion can also occur due to coordination issues between the contributor and the firm, employee training is essential to ensure that reliable data are captured (Malhotra et al., 2017). Malhotra et al. (2017) recommend strict community guidelines to reduce data-related risks. These include (a) defining open innovation tasks explicitly to avoid knowledge gaps, (b) allowing anonymous participation where personal information is not captured, and (c) explicitly instructing contributors not to engage in promotional activity. Currently, however, research into the ways in which these recommendations should be defined is scarce. For instance, what does it mean to define tasks “explicitly”? How do we test these instructions for completeness? We argue that additional interdisciplinary research synthesizing marketing communication and open innovation is essential to answer these questions.

A strict and detailed data use policy is also essential to ensure contributor confidence. This may involve public policy interventions (Corona-Treviño, 2016). A comprehensive policy, such as the General Data Protection Regulation (GDPR) in the European Union, may be

required to ensure the fair usage of contributor data. Because such policies are bound to be region-specific, however, firms will likely be able to collect more data from some regions than from others, which may place some firms at a regional advantage. Nevertheless, these currently unknown strategies must be paramount in managing risks in the open innovation process. Table 2 presents an overview of data-related risks. The table also presents a set of guiding questions that have predominantly guided research in the role of this risk and its management.

5.2. People-related risks

Innovation research often ignores the role of individuals in the innovation process (Alsos et al., 2013; T. M. and AuthorAnonymous et al., 2021). Thus, although characteristics such as the age, gender, and cultural background of contributors and of coordinators inside the firm can impact innovation processes (Grigoriou and Rothaermel, 2014), these are often ignored as influencers of the innovation process. The extant literature argues that individual-level factors also impact the open innovation process, particularly in customer-level open innovation (Kristal et al., 2018). We identify two main issues involved in contributing to the open innovation process: (a) contributor motivation-related uncertainties and (b) coordination risks.

(e) Contributor Motivation-Related Uncertainties

Chaney (2019) conceptualized open innovation systems involving customers as principal-agent systems wherein consumers are principals whom the company utilizes as agents to decide which innovations reach the market. Therefore, consumer motivations to participate take center stage in determining the success of an open innovation product or service (Bacile et al., 2014; Cao and Song, 2016; Lahtinen and Närvänen, 2020; McDaid et al., 2019; Schäper et al., 2021; Tumbat and Belk, 2013). Consumer traits such as altruism and trust have been found to positively impact the intention to contribute, while psychological ownership can lead to negative intentions (Schäper et al., 2021). Lack of trust has been

Table 2
Overview of data-related risks.

<p>Synopsis: Data risks are deviations from the ways in which data are intended to be collected, received, or appropriated. Such risks may be due to privacy concerns, data distortion, or other technical issues that lead to data leaks.</p> <p>Subtypes:</p> <ol style="list-style-type: none"> 1. Data privacy risks 2. Data distortion risks 3. Other technical risks <p>Impact on the process: Data risks can reduce trust and willingness to contribute to the open innovation process while also diminishing brand image. Although data risks can occur at any stage of the open innovation process, they may be more harmful during a direct interface with customers in the pre-ideation and ideation stages. Such risks can continue throughout the implementation phase if distorted data are transferred to the R&D team.</p> <p>Risk management techniques:</p> <ol style="list-style-type: none"> 1. Designing a strict and transparent data usage policy 2. Investing in technology security and robustness 3. Developing backup plans in case of attack 4. Establishing contribution guidelines and explicitly reminding contributors to be responsible 5. Allowing anonymous participation 6. Establishing explicit community guidelines to avoid distortion <p>Guiding RQs:</p> <ol style="list-style-type: none"> 1. What are the antecedents of data distortion in open innovation? 2. How can unreliable data influence the open innovation process? 3. What can be done to mitigate data distortion risks? 4. How do contributors perceive privacy risks? 5. What firm- and policy-level interventions are required to mitigate data-related risks?
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shown to impact the intention to engage in value co-creation in both governmental non-profit (Hu et al., 2019) and private for-profit systems (Hutter et al., 2015). Further, the perception of unfairness in outcomes can cause contributors to engage in negative word-of-mouth (Gebauer et al., 2013; Järvi et al., 2018).

In their study of the risks associated with integrating customers into the firm innovation process, Enkel et al. (2005) adequately captured the importance of individual-level interactions and the ways in which these interactions can be managed at different levels of open innovation. The study summarized several issues involved in customer integration, including the need to find the right consumer to contribute (Järvi et al., 2018), the consumer's cultural background, which can influence his or her willingness to contribute, and potential misunderstandings between the consumers who contribute and the employees who transmit the collected data (Enkel et al., 2009). Cao and Song (2016) identified the same issues with consumers in China, indicating that some risks may be universal. The possibility of cultural risks leads to issues including insufficient openness and risk aversion (Aquilani et al., 2017). On the other hand, Tranekjer (2017) noted that customers' geographical location/country of residence had varying influences on the impact of their contribution to the process. While the participation of customers from Europe and the USA led firms to abandon their research projects, the participation of customers from India and China had the opposite influence. The authors further suggested that combining customers and university contributors has the potential to reduce this risk.

The risk associated with motivating contributors is also impacted by the type of process used to extract information from contributors and the contributors' prior experience with the process. For instance, Leclercq et al. (2018) investigated the impact of the gamification of crowdsourcing events, finding that losers at these events were less inclined to contribute further because their co-creation experience was negatively impacted. This highlights the double-edged nature of motivating mechanisms, whereby gains motivate but losses do not. Although one could argue that this process builds a community of highly motivated contributors while eliminating less motivated contributors, it may eventually lead to a homogenization of the information collected. Further, events such as crowdsourcing competitions, in particular, put contributors' time and reputation at stake, which may discourage desired contributors from participating (Abhari et al., 2018). It is also important to understand that users are individuals who may have their own small businesses or freelance skills to promote; therefore, they may engage in opportunistic behavior and misuse crowdsourcing platforms for self-promoting (Malhotra et al., 2017), which can also lead to data distortion. Another issue is salience bias, whereby contributors fail to perceive implicit information in tasks and, because of their limited understanding, fail to meet the firm's goals (Lee et al., 2018).

A lack of motivation to contribute, finally, can impede contributions not only from consumers but also from other stakeholders, such as suppliers (Radnejad and Vredenburg, 2015). However, the extant literature has devoted limited attention to contributor motivation and inter-organization employee interactions with other stakeholders, such as suppliers and non-profit organizations.

(f) Coordination Risks

Open innovation presents a trade-off between control and openness (Ritala and Stefan, 2021). An organization must be open enough to allow external information to enter and to encourage participation. At the same time, being *too* open can cause the firm to lose control of the entire process (Linäker and Regnell, 2020). A failure to achieve the necessary balance can impede the coordination process in various ways. For instance, Müller-Seitz and Reger (2010) presented a case study of Wikipedia wherein a non-profit adopted a bureaucratic structure to incorporate users' contributions, which made the users feel that their participation was unwelcome. Another issue can arise from the defection of participating contributors (Rayna and Striukova, 2010).

Communicating effectively with contributors is key to ensuring their continued support for the open innovation process (Ferraris et al., 2020). Contributors do not appreciate surprises and prefer straightforward and predictable engagement. Therefore, communicating missteps is as important as communicating successes (Prior, 2013).

Importantly, coordination problems between contributors and firms' internal teams can manifest in many ways based on the type of contributor, the type of firm/industry, and the type of contribution. Past literature has noted this issue in some contexts. For instance, highlighting the fact that interactions with external stakeholders can vary with the type of industry, Svensson and Hambrick (2019) argued that sport for development and peace (SDP) organizations require a clear external perspective to reduce the risk of innovation by spreading it beyond the organizations' boundaries. Further, team characteristics, such as size, learning ability, and technological uncertainty (Kim et al., 2015), can also impact open innovation project-level openness. Another issue is employee unwillingness to incorporate external knowledge due to the "not invented here syndrome" or unwillingness to disclose internal information due to the "not shared here syndrome" (Burcharth et al., 2014). In other words, employees protective nature of their existing knowledge leads them to devalue the valuable information from the outside (Lichtenthaler and Ernst, 2006). Our review reveals that the insights on coordination risks continue to be limited, giving us sufficient reason to contend that additional research attention is necessary in this direction, particularly because contributors' perceptions play a key role in ensuring their continued participation.

(g) Managing People-Related Risks

The extant literature has devoted considerable attention to addressing people-related risks. For example, a firm that finds itself lacking the right contributors can institute strict qualifying criteria based on contributors' experience with the product or service of interest (Enkel et al., 2005). Further, gatekeeping events, such as workshops and training, can be employed to evaluate contributors prior to their acceptance into the open innovation process (Borjigen, 2015; Gould, 2012). Temporary shops represent a particularly interesting concept, whereby businesses can interact directly with target contributors (Spena et al., 2012). The prior literature has called for precisely such "transformative consumer interventions," or specific multi-faceted interventions that target consumer issues with co-creation processes that aim to reducing risks for customers while making resources available to them (Bieler et al., 2021). Another way of addressing both people-related risks and data distortion risks simultaneously involves using information from multiple stakeholders rather than one (Tranekjer, 2017). However, this approach can increase costs due to the activities involved in including and engaging multiple stakeholders. It is currently unknown, however, if this increase would be linear or exponential due to network effects. Firms can also reduce motivation-related risks by establishing assurance mechanisms to confirm for contributors that their assistance is valid (Yang et al., 2021). However, these assurance mechanisms are more effective when task complexity, novelty, and professionalization are high (Yang et al., 2021).

Coordination problems can be addressed by appropriately training employees. For example, Enkel et al. (2005) noted the importance of training employees for consumer-level interactions. It is also essential to cultivate a creative environment within the organization that enables innovation and encourages openness (Yström et al., 2015). Further, research has linked empowering leadership to inbound open innovation through employee involvement (Naqshbandi et al., 2019). Although no studies have specifically investigated the role of empowering leadership in reducing risk in open innovation, we expect that empowering leadership would enable frontline employees to take corrective action immediately, as we assume that employees would have adequate freedom to do so in an empowering environment (Naqshbandi et al., 2019). This proposition is also supported by the empowering leadership

literature, which asserts that empowering leadership can reduce stress on employees and ultimately reduce negative outcomes (Bortoluzzi et al., 2014; Windeler et al., 2017). Similar interventions for B2B interactions likewise require further investigation. In summary, an efficient stakeholder management strategy is the most effective way to handle people-related risks (Gould, 2012). Businesses must "test the waters" of stakeholder relevance and fit before jumping into the co-creation process with them. However, all the above methods require firms to possess the necessary stakeholder management skills. Recently, new types of businesses known as innovation intermediaries have appeared (Castellano et al., 2018; Janssen et al., 2014). Because these businesses help to bridge the gap between the firm and the relevant contributing stakeholders, they have been suggested as an additional means to address people-related risks (Castellano et al., 2018). By organizing the necessary stakeholder engagement events, such as crowdsourcing, and shortlisting contributors on the firm's behalf (Marjanovic et al., 2012), innovation intermediaries can absolve the firm of the responsibility to invest in these capabilities themselves. Table 3 presents an overview of people-related risks.

5.3. Firm-level risks

Firm-level risks occur when the firm or organization lacks adequate resources and skills to perform open innovation (Alberti and Pizzurno, 2017; Ferraris et al., 2020). We identify two main sources of this risk: (a) lack of adequate firm resources and skills and (b) lack of adequate managerial capabilities.

(a) Lack of Adequate Firm Resources and Skills

Open innovation is even more expensive than normal innovation (Usman and Vanhaverbeke, 2017). Open innovation involves additional search costs to locate relevant stakeholders and external information. Though open innovation can present significant benefits in risk-laden industries, these can be materialized only if the organization develops new skills and routines (Adamik and Nowicki, 2019; Usman and Vanhaverbeke, 2017). Further, because open innovation exposes a firm's

Table 3
Overview of people-related risks.

Synopsis: People-related risks result from human interaction in the open innovation process. They occur when the system discounts human presence and does not consider the idiosyncrasies of human behaviors. They also occur when employees refuse to accept external knowledge due to the "not invented here" or the "not shared here" syndromes.

Subtypes:

1. Contributor motivation-related uncertainties
2. Coordination risks

Impact on the process: Participation by unsuitable contributors or undesired input from suitable contributors can cause data distortions, which can, ultimately, lead either to failed processes or the need for additional investment to correct the deviation caused by the risk. This might involve additional search costs to identify new contributors. Friction between employees and contributors can also lead to negative brand perception.

Risk management techniques:

1. Selecting people via explicitly purposive rather than random sampling
2. Setting a strict filtering criterion for contributors based on experience with a product or service
3. Being aware of participants' cultural background
4. Holding breaking-in events, such as workshops, seminars, and temporary shops

Guiding RQs:

1. What factors can negatively impact a contributor's intent to contribute to open innovation?
2. What role do individual-level factors, such as personality, play in contributor motivation?
3. How do the people involved and their interactions in the open innovation process introduce risks to the system?
4. How can we decrease the risks introduced by coordination problems?

sensitive and unique resources to the outside, the firm also risks losing its competitive advantage (Di Minin et al., 2010). In addition, a lack of skills, such as IT skills and basic stakeholder engagement skills, can lead to inadequate processes for capturing external knowledge (Radnejad and Vredenburg, 2015). Further, firm characteristics, such as the liability of newness, can complicate open innovation due to a lack of resources (Ulvenblad and Barth, 2021). Lack of adequate processes and resources can impede the transfer of knowledge both into and within the organization (Ritala and Stefan, 2021). Another important risk can occur when a firm fails to adopt a proper open innovation policy. Shaikh and Randhawa (2022) argue that considering only ways to engage external stakeholders and designing reward structures solely for them is short-sighted but currently a widespread practice.

(b) Lack of Adequate Managerial Capabilities

The literature has also studied top management motivation to engage in open innovation as a firm-level factor. Existing studies have reported that top management support is essential for executing open innovation projects (Ahn et al., 2017; Herzog and Leker, 2010). Therefore, managerial oversight and risk-averse behavior (Kirschbaum, 2005) are other issues that can lead to deviations such as the “not invented here syndrome” (Burcharth et al., 2014; Herzog and Leker, 2010). In addition, cognitive dissonance between open innovation and what managers perceive as OI can also cause disengagement with OI (Bhimani et al., 2022).

(c) Managing Firm-Level Risks

Managing these risks requires investments in adequate resources. Further, a well-crafted public policy that articulates the required standards can help firms aim for adequate levels of competence (Corona-Treviño, 2016; Davey et al., 2011). Firms can also address risks stemming from the lack of resources and inflexibility by engaging in partnerships with other firms directly or through intermediaries (Agogue et al., 2013; Dodourova and Bevis, 2014). One study that prompted investigations in this regarding is that of Shaikh and Randhawa (2022); they argue that it is necessary to plan pecuniary and, more importantly, non-pecuniary benefits not only for external stakeholders but also for employees and top management to keep them motivated to encourage open innovation. In other words, crafting a holistic open innovation policy rather than a stakeholder engagement policy is required. This is, however, a new line of thought, and scholars have yet to pay adequate attention to the risk management steps necessary to address top manager inefficiency, which thus presents a fertile area for future research. Table 4 presents an overview of firm-level risks.

5.4. Outcome risks

Risks in open innovation are not limited to the stages of ideation and new product development. In fact, the risk involved in the decisions of the ideation and implementation stages can sometimes carry over to the output side of innovation. We identify two main subtypes of output risk: (a) market failure-related risks and (b) intellectual property risks.

(a) Market Failure-Related Risks

The innovation process intends to produce new products and services for the market. However, some studies have noted that particularly in situations where customers contribute to the open innovation process, their contribution is heavily influenced by their prior experiences with a product or service already on the market (Enkel et al., 2005). Therefore, the outcomes of such efforts are largely incremental in nature, which means that these innovations can only be used to improve existing products and services. The ways in which the open innovation process can leverage stakeholder contributions to generate more radical

Table 4

Overview of firm-level risks.

Synopsis: Firm-level risks occur due to a lack of skills, resources, and managerial foresight within the firm.

Subtypes:

1. Lack of adequate firm resources and skills
2. Lack of adequate managerial capabilities

Impact on the process: The impact may manifest as a failure to engage in open innovation and/or vulnerability to the “not invented here syndrome.”

Risk management techniques:

1. Encouraging top managers to buy in and engage in participatory leadership
2. Investing in skills and capabilities
3. Establishing policy-supported standards for the open innovation process

Guiding RQs:

1. How do managerial capabilities or the lack thereof impact open innovation implementation?
2. What firm-level resources and capabilities are required for the effective implementation of open innovation?
3. How can firms acquire these resources, and how do these resources impact risks?
4. How can firms train managers to be more receptive to the open innovation paradigm?

Table 5

Overview of outcome risks.

Synopsis: Output risks are any kind of risks that may occur once the innovation process has reached the final implementation stages and the early marketing stages.

Decisions must be made regarding how and where to commercialize the innovation and who owns what part of the intellectual property.

Subtypes:

1. Market-oriented risks
2. Intellectual property rights-associated risks

Impact on the process: IP and knowledge leaks can engender the loss of competitive advantage and a diminished brand image. The failure to safeguard IP can lead to inefficiency or an inability to extract value from innovation.

Risk management techniques:

1. Providing clarity regarding the extent of innovation to be pursued (from incremental to radical)
2. Facilitating broad-based ideation by seeking input from multiple stakeholders
3. Encouraging the participation of various stakeholders at the implementation stages to counter the market failure risks that can arise from a more narrow and siloed focus
4. Controlling but not obstructing the flow of information to ensure the desired competitive advantage versus information leakage trade-off
5. Providing legal, procedural, and strategic clarity to address the paradox of disclosure and proper management of intellectual property
6. Decoupling knowledge and China-walling stakeholders/information as required through procedural and contractual remedies

Guiding RQs:

1. What risks can occur once the innovation process is complete and ready for marketing?
2. How are intellectual property rights assigned to open innovation participants to ensure the fair allocation of gains?
3. What impact do these risks have on the firm’s financial and non-financial performance?

innovations remain largely unexplored and require further investigation. Here, we define radical innovation as the creation of drastically new products and services in collaboration with customers (Lettl et al., 2006).

Another issue highlighted in the literature is the market failure of open innovation efforts (Hatch and Schultz, 2010; Linåker and Regnell, 2020; Peine et al., 2014). One reason such efforts can fail is that firms consider only a very narrow contributor base in the ideation and implementation stages of innovation. For instance, Peine et al. (2014) explained that the failure to consider older consumers in technological innovations can decrease the usability of those innovations for older consumers and thus further impede their ability to participate in the

open innovation process. Such practices mean that open innovation may only be useable by a rather niche market segment, which can, ultimately, lead to undesirable outcomes (Cao and Song, 2016).

The opportunistic behavior of partners is also a concern (Marullo et al., 2020; Rayna and Striukova, 2010). Transaction cost economics states that under any kind of hybrid governance structure dictated by contracts, if one party finds that the benefits of breaking the contract exceed the penalties, that party will engage in opportunistic behavior and break the contract (Williamson, 1979). For instance, a software firm may make its software open source to seek the community's help in making it error free. Once its software is error free, however, the firm will have incentives to break the open-source agreement and make the code private. Therefore, contracts must be structured so that the penalties exceed the gains for breaking them. On the other hand, however, due to the open nature of their contracts, firms may fear damage to their brand image if they break their contracts because such damage may lead to fewer open innovation partners in the long run. This line of reasoning follows the argument of Ghoshal and Moran (1996), who asserted that the decision to break a contract is never so straightforward in practice. More research is required to identify the factors that may force a firm to continue in an open innovation contract, even if it seems beneficial to break it.

Finally, because it can lead to undesirable information leakage outside the firm, the failure to effectively manage open innovation processes and thereby control the flow of information has also been linked to a loss of competitive advantage (Alberti and Pizzurno, 2017; Linåker and Regnell, 2020; Ramaswamy, 2010). However, the nature of the firms involved in the open innovation process can impact the outcomes. For instance, firms in Spain gained more from radical open innovation when they collaborated with non-scientific entities rather than scientific entities, such as universities (Gómez et al., 2020).

(b) Intellectual Property Risks

Intellectual property risks can arise from multiple aspects and various stakeholders. Any organization that desires to utilize the open innovation paradigm must address the paradox of disclosure (Bogers, 2011; Ritala and Stefan, 2021). In other words, to receive external knowledge, a firm must risk disclosing its own private information (Stefan et al., 2022), which can invite misappropriation (Nunes and Abreu, 2020; Reichman and Simpson, 2016; Usman and Vanhaverbeke, 2017), imitation (Veer et al., 2016), or the loss of competitive and brand value superiority (Stefan and Bengtsson, 2017). Interestingly, however, the literature assigns this fear of losing information or reputation not only to the focal firm but also to stakeholders, such as customers, who may fear the firm's misappropriation of their contribution (Abhari et al., 2018). Therefore, proper management of intellectual property and assurances to contributors are essential to ensure that customer knowledge is not misused (Enkel et al., 2005).

Although the extant literature has observed the risk of knowledge leakage, only a few studies have advanced strategies to tackle the issue. Two main ways of tackling intellectual property risks are (i) isolation of stakeholders and (ii) contracting.

- i. *Isolation of Stakeholders*: One way to reduce undesirable knowledge leakage is to decouple knowledge between different stakeholders (Rosell et al., 2017). Another way is to devise strict contracts prior to any contribution (Rayna and Striukova, 2010).
- ii. *Contracting*: Firms can also reduce knowledge leakage by engaging in multiple IP protection strategies, including signing memoranda of understanding (MOU) and non-disclosure agreements (NDAs) at various stages of collaboration (Toma et al., 2018). Reichman and Simpson (2016) offered a list of IP protection models for pharmaceutical firms; these models cover all the above-mentioned techniques and can be summarized as effective pre-innovation contracting to determine value appropriation and partnership

termination steps. However, the literature has devoted limited attention to identifying the ideal contract structure for each stage. Further, scholars have not adequately discussed the role of industry type in pharmaceutical and drug development (Reichman and Simpson, 2016). Table 5 presents an overview of outcome risks.

5.5. Other risks

In addition to the above-mentioned categories of risks, the literature has discussed three other types of risks: (a) business environment risks, (b) free-riding risks, and (c) identity and fit risks.

- (a) *Business Environment Risks*: Open innovation requires not only a favorable internal environment but also a favorable business environment. In this context, the business environment refers to the cultural and institutional setting in which firms are embedded (North, 1991). Therefore, policy support plays an essential role in enabling open innovation (Davey et al., 2011); if this support is inadequate, however, it can also impose risks (Peter et al., 2020). Unfortunately, policy support as a risk-reducing mechanism has received considerably less attention in the extant literature. Although some guidelines exist for data use, guidelines specific to open innovation issues are lacking.
- (b) *Free-Riding Risks*: Another contextual factor is the impact of the network of stakeholders on the open innovation process. Free-riding problems in this network are a major concern, particularly in open innovation systems, such as open-source software (Ciesielska and Westenhof, 2016). Some contributors may simply continue appropriating value from the network without contributing anything to it. In R&D alliances, this entails a trade-off between common (network) and private benefits (Arslan, 2018). An ideal system should require firms to benefit the public to gain their own private benefits. However, research to this end in the context of open innovation networks is currently lacking.
- (c) *Identity and Fit Risks*: Finally, it is important to note that open innovation fundamentally differs from the more common closed system innovation (Bogers et al., 2017). Therefore, firms experience conflicts in their identity when they make the transition to the open system. In cases involving public-private partnerships, for example, the process of changing identities to adopt new roles is challenging for all parties involved (Torfing et al., 2019). When the partners' natures differ, as in the case of a partnership between for-profit and not-for-profit firms, this may also lead to an issue of fit (Dahan et al., 2010). This indicates that the nature of the firm is another important factor in determining open innovation success. An additional important parameter is firm size. Although small and medium-sized enterprises (SMEs) are—due to their resource poverty—expected to struggle more with open innovation than are larger enterprises (Dubouloz et al., 2021; Kraus et al., 2020a,b), Ullrich et al. (2018) argued that the difference exists primarily among SMEs themselves rather than between SMEs and larger firms. In the absence of more such studies, however, we are left to wonder how firm size impacts risks. On the other hand, SMEs are known to be more agile and quicker at decision making (Ács and Audretsch, 1990; Audretsch et al., 2014), which leaves them better able to identify risks quickly. Again, though, we are unsure if this agility helps due the lack of adequate studies.

6. Framework development and future research agenda

The main objectives of this review include 1) synthesizing a risk assessment and management framework for various open innovation risks based on the reviewed literature and 2) identifying gaps and future research avenues with the potential to advance the academic and

practical assessment and management of various open innovation risks. Our detailed qualitative content analysis of the extant literature has revealed extensive insights regarding the risks associated with open innovation and various strategies for handling them. These accumulated insights are interesting, pertinent, and actionable, motivating us to synthesize and build upon them to develop a comprehensive model or framework that brings together the risks associated with open innovation and the most efficacious strategies for managing them. Recognizing that risk is an unavoidable part of the open innovation process, we have formulated this framework as a handy risk assessment tool to guide future researchers and practical decision-makers' efforts to mitigate and manage various risks. Fig. 4 presents our model—the risks in open innovation (RIO) framework. It comprises four main components, which are visualized as four distinct blocks: (a) the open innovation process, (b) the various risks in open innovation and the stages of innovation impacted, (c) possible risk management approaches to address these risks, and (d) the circumstantial environment. Each of these components is discussed below:

- (a) *The open innovation process* is the actual set of routines and tasks involved in making innovation happen. This includes identifying the participants capable of contributing to the process in multiple ways, motivating them to contribute appropriately and, finally, leveraging the inputs gathered to galvanize the firm's internal R&D process and thereby create value. Importantly, this process may differ for different stakeholders, such as customers, suppliers, NGOs, and others, but the basic flow remains the same. Given the nature of routines and tasks and the involvement of diverse stakeholders, the possibility of risk disrupting the process's smooth flow cannot be denied.
- (b) *Various risks in open innovation and the stages of innovation impacted provide a bird's eye view of the broad categories of risks that may surface during the open innovation process and the stages where their impact may be felt.* Although their impact can be felt at all levels of the innovation process (upstream activities, such as ideation, and downstream activities, such as development, manufacturing, marketing, and distribution; Filiou, 2021), we can infer that some risks are more prominent in either upstream or downstream activities. For instance, although unreliable data due to less motivated contributors can impact downstream processes, the main source of people-related risk is in the upstream. In general, uncertainty from risks flows

downstream. Nevertheless, risk may flow upstream—for instance, when an unequal distribution of benefits reduces contributors' motivation. Therefore, it is pertinent to note that these risks are not discrete or static; rather, because they can travel through the entire process, they are continuous, overlapping, and dynamic. To elaborate, the five categories of risks that emerged from the thematic analysis of the reviewed literature (i.e., people, data-related, outcome, firm-level and other) are—irrespective of distinct typification—not mutually exclusive. Rather, they are multiplicative, which means that they can reinforce and prompt one another.

- (c) *Risk management approaches to address the identified categories of risks* elucidate the ways in which open innovation process owners can address, mitigate, and manage various risks via potential interventions and strategies. The existing scholarship has devoted significant attention to various types of risks that may surface during the open innovation process and the ways in which these risks have been addressed in the past and/or can be addressed in the future. Contending that effective risk management must anticipate and address risks as soon as they appear—if not sooner, past studies have underscored the necessity of firms' flexibility to get a project back on track after any such deviations (Prior, 2013). In fact, scholars have devoted increasing interest to a variety of proactive measures for controlling open innovation risks (Onuchowska and De Vreede, 2017; Toma et al., 2018), which highlights the growing importance of the area.

In a similar vein, drawing upon the literature, we argue that the coordination of practices between process owners and stakeholders through a well-designed corporate open innovation policy is essential to control the multiplying and reinforcing effect that various categories of risks may have on each other. At the same time, understanding the reasons behind coordination-related issues is critical because coordination failures can harm the open innovation process from the very beginning. For instance, the ongoing failure of contributors and employees to coordinate may be due to the firm's initial selection of the wrong contributors at the pre-ideation stage (i.e. a people risk). Firms can overcome such challenges by establishing relevant policy guidelines that include selection criteria based on potential contributors' prior experiences with a product or firm. Pre-defining these requirements is likely to minimize coordination issues downstream, which, in turn, is likely to minimize data distortion even later in the process. While this

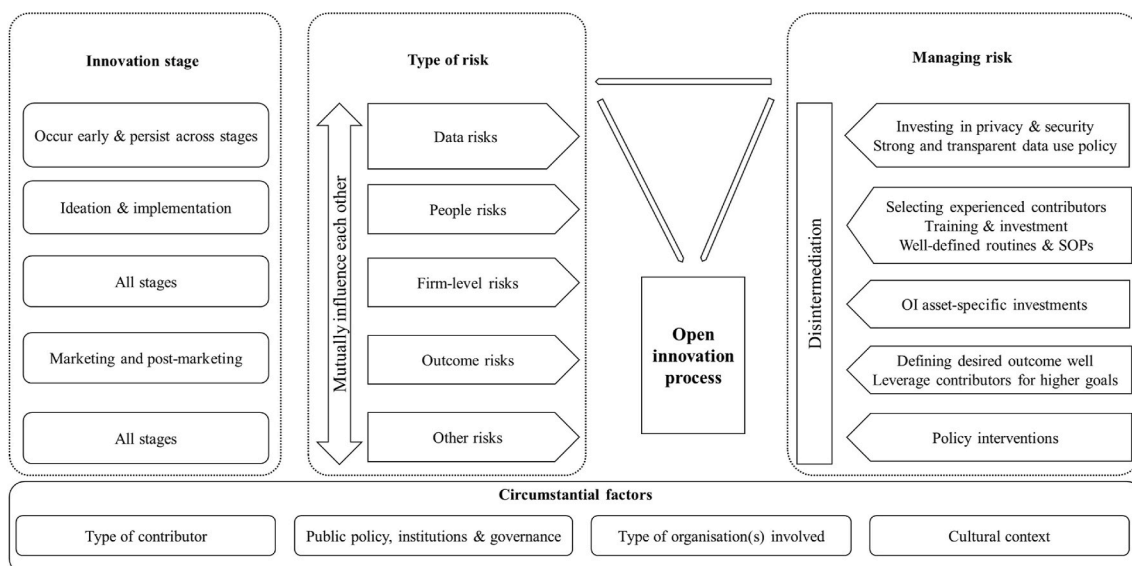


Fig. 4. Risks in open innovation (RIO) framework.

underscores the intertwined nature and stages of innovation from a policy perspective, research attention to this aspect remains deficient.

- (d) *Circumstantial factors* are parameters that are not under the control of the firm but nevertheless represent risks to its operation. These may be seen as risk factors that arise from the broader environment in which the firm operates. Some of these circumstantial factors are covered under the category of “other” risks. Circumstantial factors, which can be contextual or situational, can exacerbate the risks that surface during the open innovation process. For instance, the liability of smallness (Stinchcombe, 1965) may render resource risks a larger issue for a small firm than for a large firm. Similarly, a firm in a poor institutional environment is likely to face greater risks than a firm operating in a sound institutional environment. Clearly, these factors create differences among firms and can thus act as moderators affecting the strength of risk-performance and/or open innovation risk-risk management relationships. Academic research has widely accepted the role of third variables in illuminating the tested relationships more realistically, and the literature on risks in open innovation has likewise been mindful of these factors, making the relevant findings more robust and contextual.

6.1. Using the proposed RIO framework to motivate and advance the research agenda in the area

Our analysis in formulating this framework revealed that although the relevant research has been robust, granular, and insightful, it includes certain lacunae that must be addressed for the field to advance. These visible gaps are related to antecedents, moderators, and remedies. Specifically, the most prominent gaps are as follows:

- (i) The role of intermediaries and the impact of disintermediation are poorly understood.
- (ii) Research focused on micro-perspectives of open innovation risk is less developed than research focused on macro-level findings.
- (iii) The extant literature has only superficially explored the impact of the circumstantial factors that capture the diverse contexts and situations under which the open innovation process unfolds.

Recognizing these gaps, we discuss them in detail and suggest research questions that can be contemplated and explored via the RIO to enrich the literature in the area.

- i. *The Role of Intermediaries and the Impact of Disintermediation*: Firms pursuing the open innovation agenda always face the question of whether to conduct the open innovation process themselves or to involve an intermediary from outside the firm. Although the literature has not ignored this issue, scholarly attention has not been adequate, especially considering the myriad challenges associated with such a decision. Nonetheless, the extant research does offer a certain perspective, which can be delineated into two parts. While one cluster of studies has recommended risk-specific interventions, the second cluster has suggested disintermediation through innovation intermediaries as a potential management approach (Agogué et al., 2013; Aquilani et al., 2017; Castellano et al., 2018; Janssen et al., 2014; Troll et al., 2019). Highlighting the dilemma, scholars have argued both for and against intermediation and disintermediation. Troll et al. (2019) contended that including an intermediary can increase engagement in the open innovation process and thereby encourage participants to complete their contributions. Further, they observed that the intermediary absorbs any fallouts from failures and can even play the strategic role of network coordinator between firms that are incapable of pursuing open innovation alone (Agogué et al., 2013). On the other hand, moving the open innovation process

outside to a third party and then returning with the required knowledge might create a new set of open innovation risks that have likewise not been adequately explored. Further, scholars have examined the type of intermediation required only from a cultural perspective (Aquilani et al., 2017). This indicates the need for keener research attention to identifying an appropriate intermediary and then executing the open innovation process through that intermediary (Troll et al., 2019). Based on the preceding discussion, we suggest the following tracks/themes, which, when addressed, have the potential to advance research in the area:

- Categorizing various types of intermediaries based on their role in reducing the risks involved in open innovation
 - Identifying the risks intermediaries induce into the open innovation process
 - Devising parameters for evaluating intermediaries based on their contributions to risk mitigation
 - Evaluating the potential costs and benefits of disintermediation in terms of risks associated with the open innovation process.
- ii. *Micro-Perspectives on Open Innovation Risk*: For ease of understanding, we examine micro-perspectives on open innovation risk from both internal (firm-level) and external (customer-level) perspectives. Admittedly, previous studies have successfully investigated the impact of several individual and interpersonal factors on the open innovation process. However, the prevailing approach has been broad and has thus failed to address some deep-rooted firm-level risks. For example, a specific approach for addressing managerial inefficiency does not yet exist and presents a fertile area for future research. Similarly, the value of top management team diversity in reducing other business risks has been much debated, but these debates remain inconclusive. In sum, noting that micro aspects related to process owners and top management require a deeper research focus, we suggest the following potential themes/tracks:
- Identifying top management characteristics, such as openness or participatory leadership, that may facilitate or impede open innovation risk management approaches
 - Identifying process owner and project manager skill sets suitable for various types of risk management interventions.

Human resource management aims to handle the potential personnel-related fallout of various interventions, approaches, and strategies to counter the risks involved in the open innovation process. Most of the existing literature has investigated consumers’ intentions to contribute to the process (e.g. Shirazi et al., 2021). Because intentions differ from actual behavior (Sheeran, 2002), however, we contend that efforts to understand intentions might not be sufficient. Indeed, the well-documented intentions-behavior gap might surface in this context as well and thus further enhance the risks associated with the open innovation process. Consequently, we argue for additional research to study the existence of such a gap and the risks that might surface as a result. Specifically, the following tracks/themes are worth exploring to enhance research in the area:

- Investigating the possibility that an intention-behavior gap introduces and exacerbates people-related risks in the open innovation process
 - Investigating the possibility that the negative fallout of people-related risks originates from customer perceptions regarding costs, quality, delays, and outputs
 - Devising potential risk management interventions, approaches, and strategies to counter risks arising from the intention-behavior gap.
- iii. *The Impact of Circumstantial Factors Capturing Different Contexts and Situations*: Our proposed framework accords a great deal of significance to the role of factors such as the type of contributors and organizations involved, public policies, institutions and governance, and cultural context. In this regard, we support the call for additional research into the moderating effect of

contributor and organization type on open innovation risks and outcomes; however, we specifically note the need for more intense investigations of factors related to public policy, institutions, and governance. Some previous studies have raised similar concerns. For instance, [Corona-Treviño \(2016\)](#) observed that a lack of standards and policy guidelines was an issue in open innovation. Other situations where a lack of policy guidelines and unclear corporate policies may increase the risks of open innovation include the handling, storage, and analysis of collected data. Because these situations could raise substantial privacy and security concerns for contributors, they may threaten the entire open innovation process.

Similarly, the open innovation process is vulnerable to risks arising from the various partners with which firms must engage to navigate the process successfully. While these risks may be related to autonomy and information flow, the lack of corporate policies and governmental guidelines regarding the related contracts and a lack of institutional support to reinforce the same can likewise prove detrimental for the firms involved. Past studies have asserted the need to create a policy-driven ecosystem in which it is easy to identify and interact with open innovation partners ([Corona-Treviño, 2016](#); [Ferraris et al., 2020](#)). However, such studies are limited in number, and research addressing the role of policy in standardizing and creating clusters remains deficient. This suggests that scholars can contribute to this area by focusing on the following tracks/themes:

- Identifying the procedural and conceptual ways in which firms and governments can create open innovation standards
- Seeking correlations between created standards and risks at various levels of the open innovation process to make policy initiatives more efficacious.

7. Discussion and conclusion

Two primary research questions and their associated research objectives guided our efforts in this review. *RQ1*, which aimed to delineate various sources of risks in the open innovation process, aligned with the research objective of enumerating and classifying the risks involved in open innovation. Meanwhile, we addressed *RQ2*, pertaining to various risk management approaches for each of the identified risks, through two research objectives, synthesizing and consolidating the risk management techniques for each of the risks and synthesizing a risk assessment and management framework for these risks. To respond to the above-stated research questions and achieve the guiding research objectives, we began by identifying relevant studies through a well-defined search protocol executed on two of the largest and most widely used databases, *Scopus*, and *WOS*. Thematic analysis of the identified literature enabled us to identify five clusters/typologies of risks involved in the open innovation process: data-related risks, people-related risks, firm-level risks, outcome risks, and other risks.

The analysis that served as the basis for clustering risks also revealed that risks rarely occur by themselves and that different types of risks can often overlap, interact, or reinforce one another, thereby multiplying their negative influence. Thematic analysis of the selected studies further allowed us to summarize various risk management techniques to mitigate risks that may surface at different stages of the innovation process. To this end, we captured various risk assessment strategies discussed in the literature, highlighted several questions regarding risk management that remain unanswered, and thus offer interesting future research opportunities. Finally, we sought to advance research on open innovation by integrating our findings in a simple yet comprehensive framework. Overall, our efforts to uncover key risk typologies, identify major risk management approaches, and formulate an overarching framework helped us to understand the underlying research more deeply and thereby identify several research gaps related to both content and methodology. In this way, we were able to present a concrete

agenda to advance future research through potential research questions, themes, and tracks. We have summarized the key theoretical and practical implications of our review below.

7.1. Theoretical implications

Our study makes three main theoretical contributions. First, ours is among the first reviews to focus exclusively on the risks of the open innovation process. Although some niche studies have summarized risks in instances where customers have contributed to the process of co-creation (e.g. [Enkel et al., 2005](#)), a more general and broader-based review was lacking. We address this gap by reviewing the extant literature to present a typology of risks and the ways they can be managed. The five types of risks we identify can guide future researchers to understand the state of the art more clearly and formulate their related research questions more effectively. Moving from general classification to more specific takeaways, our review highlights the limited nature of research into the human aspect of open innovation. Because open innovation processes are largely social systems, examining human-level factors is essential to understand the risks involved. Furthermore, by consolidating the key risks into different clusters with distinct boundaries, we pave the way for research aimed at developing scales to measure these types of risks.

Second, our thematic analysis reveals that open innovation risks are contingent on various contextual factors at the firm and business environment levels. This observation can motivate future researchers to explore these factors as potential moderating variables. Through the RIO framework, we provide a bird's eye view of the risk ecosystem of open innovation. Although risk assessment has been a core part of the open innovation process ([Chakraborty, 2018](#); [Prahallad and Ramaswamy, 2004](#)), our synthesis facilitates a greater appreciation of the ways in which these risks emerge and the ways in which they can be addressed. We believe that our analysis adds potentially new variables for future research to explore.

Finally, our summary of the most promising research outlets and trends shows that the majority of scholarly contributions are being generated through technology management and marketing journals. This confirms marketing and technology-oriented journals as favorable outlets for publishing research on risks in the open innovation process. Noting the increasing popularity of research into online communities, we predict that people and data risks are likely to be major topics of research in the coming years.

7.2. Managerial and policy implications

Our study also provides key implications for managers and policy-makers. First, our typology presents a formal map of the key risks associated with the open innovation process; managers and process owners can employ this typology as a ready guide for their own risk assessments. To elaborate, concerned stakeholders can easily identify the kinds of risks their projects are currently facing while also anticipating risks to which they might, in the future, become vulnerable; in turn, they can proactively introduce commensurate interventions and corrective actions to mitigate these risks. The RIO framework we proposed further formalizes the entire risk-recognition-assessment-management process, which can not only be used to evaluate and address imminent risks but also to create standard operating procedure (SOPs) to tackle the same risks in the future.

Second, by underscoring the potential threat of the intentions-behavior gap when customers are involved as contributors in the process of open innovation, we provide useful input for practitioners baffled by customers' tepid or evasive responses to requests for their involvement. The insights our paper offers can help concerned managers develop viable engagement strategies to stem the related risks at their inception and thus ensure that customers' intentions to contribute to the process actually materialize.

Finally, for policymakers, our review reveals the current lack of well-defined public and corporate policies to handle open innovation risks. This implies that the processes and procedures to anticipate, avert, and resolve risk-related SOPs, contracts, legal recourse, and institutional remedies are not yet robust, exposing firms engaged in open innovation to a variety of risks. This policy-related gap is particularly glaring in the case of data collected during co-creation. Even more concerning is the fact that the lack of adequate standards can exacerbate existing data and firm-level risks and introduce new ones during different stages of the process. Taking the discussion further, without any guidelines on system privacy and quality standards, it may even become difficult for firms to design the underlying systems. Therefore, we argue that the co-creation of policy must involve firms, customers, contributors, and the government in establishing standards and identifying milestones in the open innovation sphere. Additionally, the resulting policies should be segregated by industry because some industries, such as the medical and pharmaceutical industries, may have entirely different requirements than others, such as IT.

7.3. Limitations

The purpose of the current review was to render some structure to the risks associated with the open innovation process and thus guide future researchers and practitioners alike. Although our work presents useful implications for both theory and practice, it also entails some limitations. These limitations primarily pertain to the study selection process. First, to ensure the high quality and replicability of our review, we considered only empirical work published in peer-reviewed journals. Further, we limited our search to articles published in English. Although this is a common practice in SLRs, it might have led us to exclude some conceptual studies and/or studies published in non-peer-reviewed journals. Second, we did not include research regarding inter-firm R&D alliances because we observe the evolution of a separate, more sophisticated stream of literature on the topic. However, excluding these studies might have led us to exclude certain risks. We encourage researchers to address these limitations in future reviews of the literature regarding risks in open innovation. Our review also opens possible future research avenues into other related topics, such as costs hurdles or barriers to open innovation.

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