



Organizational enablers for the implementation of inbound open innovation projects

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Abstract

Inbound open innovation (IOI) refers to the systematic integration of external technologies, knowledge, or know-how into a firm's internal development processes to drive innovation and maintain competitiveness. Despite the recognized potential of IOI in this regard, there is a limited empirical understanding of specific intra-organizational enablers that facilitate its successful implementation. This study addresses this gap by empirically testing and validating intra-organizational enablers for IOI within a theoretically grounded framework. Using multivariate regression analysis on a dataset of 73 German manufacturing companies, we find that IOI project success is strongly contingent on adaptive governance structures that balance strategic oversight with operational flexibility. Our findings therefore reveal that IOI often resembles radical innovation, necessitating flexible and adaptable governance models rather than rigid, formal leadership structures. Specifically, decentralized decision-making at the project level, combined with senior management steering, enhances responsiveness to uncertainty, while standardized knowledge-sharing mechanisms mitigate the challenges of non-repetitive innovation processes. Hence, this study not only provides new insights into the intra-organizational enablers that support IOI but also offers practical recommendations for effectively managing IOI initiatives.

Keywords Open innovation · Inbound open innovation · Inbound innovation · Innovation management · Outside-in-innovation · Innovation organization

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1 Introduction

Open innovation (OI) encompasses various modes of external knowledge utilization, including inbound open innovation (IOI), outbound open innovation (OOI), and co-innovation (Gassmann and Enkel 2004). An IOI project is a development project in which technologies, patents, knowledge, or know-how from outside the company are purposefully pursued and systematically introduced into the company's internal product development process, either for a fee or free of charge, with the aim of transferring technology or knowledge (Chesbrough 2003; Tang et al. 2021). IOI can therefore also be referred to as outside-in innovation (Arora and Gambardella 2010; Du et al. 2014). In contrast, OOI involves the external commercialization of internally developed knowledge, such as through licensing or spin-offs, while co-innovation describes collaborative innovation efforts between firms or with external stakeholders (Helm et al. 2019, 2020). While all three OI approaches contribute to a firm's innovation strategy, IOI is particularly critical in industries characterized by short technology cycles, increasing technological complexity and rising development costs where accessing external knowledge can significantly enhance a firm's innovation capacity as well as its capability to maintain competitiveness (Bauer et al. 2018; Helm et al. 2019; Kloyer et al. 2019; Dziurski 2020; Hunt and Madhavaram 2020; Kraft et al. 2021; Pilav-Velic and Jahic 2021).

Despite its growing interest and strategic importance, research on IOI has predominantly focused on its external dimensions—such as sourcing strategies and partner selection—while neglecting the intra-organizational enablers that facilitate its successful implementation (Burcharth et al. 2014; Bianchi et al. 2016; Hossain et al. 2016; West and Bogers 2017). This gap is particularly critical, as IOI requires firms to balance the integration of external knowledge with internal coordination and decision-making processes (Bogers et al. 2018; Markovic et al. 2020). Existing studies suggest that organizational complexity, high coordination costs, and ambiguous governance structures often hinder the effective execution of IOI (Faems et al. 2010; Huizingh 2011). However, it remains unclear to what extent firms should structure decision-making authority, allocate specialized roles, and formalize processes to maximize IOI outcomes (Markovic et al. 2020). Furthermore, research on IOI implementation is fragmented and yields contradictory findings, particularly regarding the role of formalization and governance mechanisms (Burcharth et al. 2014; Hossain et al. 2016; West and Bogers 2017). For instance, while some studies highlight the importance of structured decision-making processes in mitigating uncertainty (Gentile-Lüdecke et al. 2020), others argue that rigid formalization suppresses the adaptability required for IOI success (Bogers et al. 2019). Additionally, many contributions remain conceptual, firm-specific, or based on qualitative insights, limiting their generalizability to broader organizational contexts (Bogers et al. 2018, 2019; Tiberius et al. 2021; West and Bogers 2017; Boscherini et al. 2012; Buganza and Verganti 2009; O'Connor and DeMartino 2006). These inconsistencies are reflective of a broader issue in innovation theory: the heterogeneity of innovation projects often leads to contradictory theoretical insights, as governance requirements vary significantly depending on the specific innovation context. A one-size-fits-all approach is therefore insufficient. Instead, systematically testing governance enablers within a

clearly defined empirical setting allows for more precise theoretical insights while ensuring applicability beyond the focal context. Hence, this study contributes to this discourse by empirically testing the effects of key intra-organizational enablers on IOI success. Specifically, from innovation literature, the design of decision-making and organizational structures, formalization, and the role of the management team were identified as relevant enablers. Unlike previous research, which predominantly adopts a firm-level perspective (West and Bogers 2017), we focus on the project level, where governance structures directly impact IOI implementation (Sandberg and Aarikka-Stenroos 2014). This distinction is crucial, as governance mechanisms effective at the firm level may not necessarily translate into optimal project-level structures (Fey and Birkinshaw 2005; Felin and Zenger 2014). We deliberately focus on German manufacturing firms as our empirical setting. While this narrow focus strengthens internal validity, we acknowledge that it may limit cross-context generalizability—an aspect we explicitly address in chapter 6. By systematically testing established theoretical enablers in this specific context, we contribute to both theoretical refinement and managerial practice, bridging the gap between conceptual frameworks and empirical validation.

2 Implementation of inbound open innovation: theoretical conceptualization

IOI aims to reduce competence deficits and development costs, to speed up new product development and is in many cases the basis of radical or incremental innovation. Both represent a different classification of the innovation regarding the degree of novelty (Chesbrough and Brunswicker 2013). Radical innovation is characterized by a high degree of novelty in terms of technologies and markets and usually occurs when a new technology is applied to a specific application in a company (Dewar and Dutton 1986). Radical innovation is therefore associated with high technical uncertainty, entrepreneurial risk, lack of experience, new markets and high development costs for the adapting company (McDermott and O'Connor 2002). In contrast, incremental innovation, on the other hand, is often based on existing technologies and can be produced comparatively quickly, with a high degree of certainty and competence. Hence, it can also be connoted with the terms optimization, improvement, and further development (Dewar and Dutton 1986). The distinction between these innovation types alongside IOI is therefore fundamental as the literature suggests that different innovation types require distinct governance approaches to optimize innovation performance. Accordingly, IOI might serve as a mechanism for integrating external knowledge, which might either help refine and optimize existing technologies—aligning with incremental innovation—or facilitate the adoption of novel, disruptive technologies characteristic of radical innovation. Understanding whether IOI aligns more closely with radical or incremental innovation is therefore critical, as it provides insights into which established management and governance approaches may be applicable to IOI projects. Additionally, IOI projects can be understood as ex-post market transactions embedded in technological alliances of some sort and thus be clearly distinguished from development outsourcing (Arora and Gambardella 2010;

Du et al. 2014). Hence, R&D contracts should not be considered IOI projects. Furthermore, IOI differs from other external knowledge acquisition mechanisms, such as technology transfer by human capital, which is more closely associated with the market for labour and M&A, which operate at the firm level rather than the project level (Gans and Stern 2010).

Grimpe and Kaiser (2010) show that the utility function of IOI follows an inverted “U”. To have a positive impact on innovation performance, an intelligent combination of in-house development and IOI as well as adequate, high-quality project management is necessary (Helm and Kloyer 2004; Alexy et al. 2016; Lakemond et al. 2016). Helm et al. (2019) add that high levels of external R&D might lead to knowledge loss, high dependencies, a loss of integrative capabilities and subsequently often a deterioration of the competitive position.

To identify the relevant state of research, a structured literature review was carried out based on Tranfield et al. (2003). Based on the research questions underpinning the paper, the terms “inbound innovation”, “inbound open innovation”, “empirical study” and “empirical research” were used to search for abstracts in various meta databases, including Science Direct and EBSCO Host. To limit the results to articles relevant to this paper, the period was restricted to publication dates from 2004 to 2023. The time period chosen ensures that as many relevant contributions as possible since the publication of important fundamental work on inbound innovation—primarily by Chesbrough (2003) and Gassmann and Enkel (2004)—could be considered. Furthermore, the results were limited to the subject area “Business, Management and Accounting”, the language English and to peer-reviewed articles in scientific journals that were ranked as 2 in the CABS Academic Journal Guide 2018 and C in the VHB Jourqual 3. In line with the research question and the methodology used by Leemann and Kanbach (2022) the articles were filtered with regard to the keywords “organization” and “implementation”. The articles remaining after applying these filters were examined for enablers for the implementation of IOI based on their content. To provide an orientation framework for the assignment of the articles to categories for the implementation of IOI, overview papers by West and Bogers (2014), Gassmann et al. (2010), Boscherini et al. (2012), and El Maalouf and Bahemia (2023) as well as other articles partly referenced within these were included in the sample. These were selected as they outline overarching theoretical concepts relevant to IOI. A detailed flowchart illustrating the structured literature review process is provided in the “Appendix”. This sample was then initially analyzed in-depth regarding enablers for the implementation of IOI and afterwards aggregated into distinct categories which were based on the Gioia et al. (2013) method. By searching for similarities and differences between the enablers identified in the studies, first and second-order themes and aggregated dimensions were synthesized and compared with existing reviews (Leemann and Kanbach 2022). This process resulted in four first-order categories: strategy, competence, organization, and culture, and 11 second-order themes according to which empirical work on enablers of IOI can be categorized. Due to the high practical relevance which has proven to be evident on the basis of the literature analysis, the category organization covering aspects like organizational design, the innovation process as well as management & leadership has been chosen as a focus

topic for this research (Hossain et al. 2016; West and Bogers 2017; Burcharth et al. 2014; Chiaroni et al. 2010; Huizingh 2011; Gentile-Lüdecke et al. 2020).

2.1 Organizational design

The discussion in the literature on organizational structure circles around the influence of the key design parameters known from organizational theory, specialization, centralization and formalization, and their influence on the IOI performance of a firm (Gentile-Lüdecke et al. 2020; Claver-Cortés et al. 2012). Specialization refers to the distribution of tasks within the organization and the location where these tasks are performed. Centralization refers to the location within the organization where decisions are made and the distribution of decision-making power. Formalization describes the degree to which formal role descriptions, work instructions, process descriptions, and the like shape the way an organization works.

Generally, it is assumed that **specialization** is beneficial for innovation activities, since it increases task-orientation, the efficiency of task execution and foster creativity and speed by reducing the dependency on established processes and traditions (Felin and Powell 2016; Miles et al. 2009). For IOI there is a discussion about the optimal level of specialization. Some authors demonstrate that companies with highly specialized inbound organizations have comparatively stronger absorptive capabilities and are better at absorbing and processing knowledge (Felin and Powell 2016; Gentile-Lüdecke et al. 2020; Miles et al. 2009; Pertusa-Ortega et al. 2010; Schmidt and von der Oelsnitz 2020). Others can confirm that specialization has disadvantages due to low conformity and suggest it is only useful, if companies want to substitute internal R&D with IOI (Ihl et al. 2012; Lee et al. 2016; Will et al. 2019).

There is evidence indicating that the design of organizational structures for innovation depends on several contextual factors. The degree of specialization influences the frequency of external technology acquisition and whether a science or market-oriented project is pursued (DeSanctis et al. 2002). High technical dynamics and technical complexity forces firms towards specialization and decoupling from central R&D for IOI (Buganza and Verganti 2009). Low complexity, low knowledge gap problems are resolved within the company, whereas high complexity, high knowledge gap problems are resolved via cooperation and market transactions (Bröring and Herzog 2008; Felin and Zenger 2014).

While it is quite common to integrate IOI projects via a team approach with centralized decisions, governance models where an individual builds the bridge from an IOI project to the core of the organization are largely unexplored (Pellizzoni et al. 2019). There is evidence from general, radical, and open innovation projects that so-called liaison positions are more suitable to coordinate decentralized units, due to less direct control, a more informal coordination and as a result a stronger emphasis on expertise and more problem-targeted innovation (DeSanctis et al. 2002). Liaison positions can lead to improved innovation project performance by helping innovation teams to focus by adding experience, taking care of administration and communication (Boscherini et al. 2012; Buganza and Verganti 2009; O'Connor and DeMartino 2006).

It is commonly assumed that the **centralization** of decisions on innovation, in general, has a negative impact on a company's innovation performance. This is mainly attributed to individual opportunism, a lack of openness and information, and low willingness to change by top management (Ihl et al. 2012; Miles et al. 2009; Schmidt and von der Oelsnitz 2020). Additionally, a low degree of centralization is assumed to encourage the involvement of a greater number of individuals and hierarchy levels, knowledge, and information in the decision process (Claver-Cortés et al. 2012; Pertusa-Ortega et al. 2010). Nevertheless, studies on IOI show contradictory results. Centralization lowers transaction and coordination costs for decision making (Gentile-Lüdecke et al. 2020). In addition, centralization assures efficiency, target orientation and strategy conformity of IOI activities by ensuring high involvement of top management (Felin and Powell 2016). Lee et al. (2016) show that for OI the effect of decentralization is nonlinear. To a certain extent, decentralization of decisions has a positive effect on IOI performance. However, if decentralization becomes too strong, the positive effect on innovation performance disappears. Will et al. (2019) conclude that centralized, strictly hierarchical decisions lead to significantly better IOI performance due to better risk management and accountability.

Regarding the impact of **formalization** on IOI, there is also a lack of specific evidence and conflicting views. With respect to general innovation there is a prevailing view in the literature arguing that successful innovation requires largely autonomous organizational structures based on the principle of self-organization and the lowest possible degree of formalization (Felin and Powell 2016; Miles et al. 2009; Schmidt and von der Oelsnitz 2020). To cope with the complexity and dynamics of innovation in knowledge- and cooperation-intensive industries, companies need to continuously generate, distribute, and apply knowledge, which can be hindered by strong formalization (Lakhani et al. 2013).

For IOI there are contradictory results. Brunswicker and Chesbrough (2018) report that surveyed managers complain about a lack of formalization and usefulness of the processes and routines available for IOI and that the literature also offers little remedy. As aspects of formalization relevant to the management of IOI, the authors identify process formalization in the sense of defined activities documented in manuals, and result formalization in the sense of performance, cost, and deadline targets. Gentile-Lüdecke et al. (2020) find that IOI is highly uncertain, and formalization gives guidance on how to set targets and goals, formalize information flows and guide decision-making. Ihl et al. (2012) add that formalization provides employees with best practices, fosters the circulation of knowledge and thus reduces ambiguity and can show a comparable effect of formalization for OI practices. Formalization provides employees with best practices, fosters the circulation of knowledge and thus reduces ambiguity.

2.2 Innovation process

Although many publications point out the importance of innovation processes, few explicitly address the design of these processes and their impact on IOI performance (Roszkowska 2017). Lakemond et al. (2016) make evident that IOI management procedures refer to formal plans and milestones, assessments of collaborative proj-

ects, and measures aimed at controlling and managing projects. Nevertheless, the authors find that management procedures primarily show a positive effect on innovation performance in the early stages of the innovation process, but not in the late stages. Du et al. (2014) find that formal management processes may work differently for various types of outside-in innovation projects. Market-based-partnerships are affected positively by strict formal management processes, whereas science-based-partnerships perform better if managed with lower degrees of formality. The authors conclude that this presents a dilemma, as different project management approaches must be pursued for different project types. Formal innovation processes differ from formalization. Formal innovation processes relate to the question of how much standardization and process fidelity is helpful in innovation processes. Formalization, as discussed before, is holistically related to the organization and raises the question of how strictly standardization is applied within an organization to coordinate the organizations activities (Manolopoulos et al. 2011).

2.3 Leadership

There is a series of articles pointing to the important role management teams play for the success of IOI. For example, Gad David et al. (2023) and Naqshbandi et al. (2019) show that empowering leadership affects innovation culture and absorptive capacity of a firm and thus helps to promote IOI and OOI. Ahn et al. (2017) identify a positive basic attitude, entrepreneurship, patience, education, and professional experience as beneficial personal characteristics that foster the adoption of IOI projects. Chan et al. (2017) find that cognitive ability, personality, innovation motivation and innovation knowledge have a positive influence on the IOI and OOI performance. Naqshbandi and Jasimuddin (2018) report a positive relation between knowledge-related leadership and IOI and OOI performance. Lu et al. (2022) show that diversity in terms of age in top management members has a negative effect on IOI performance. In contrast, the authors find a positive effect for functional diversity. In addition, there are many more articles that casually argue the importance of the management team's commitment to the success of IOI projects (Chesbrough and Crowther 2006; Huizingh 2011; Rampersad et al. 2020; Tohidi et al. 2012). Nevertheless, evidence on the impact of management commitment on IOI performance is rare and in addition it is often unclear what is meant by management commitment, as it is often only unconsciously described as "involvement" (Wijethilake and Lama 2019).

3 Research framework and hypotheses

As outlined, findings on the implementation of IOI are contradictory, yet not holistic and partly qualitative or anecdotal (Burcharth et al. 2014; Hossain et al. 2016; West and Bogers 2017; Bogers et al. 2018, 2019; Tiberius et al. 2021). This can be illustrated in particular with regard to the role of formalization in its implementation. While traditional innovation literature suggests that flexible and decentralized structures foster IOI (e.g., Miles et al. 2009; Felin and Powell 2016; Schmidt and von der Oelsnitz 2020), studies specifically examining IOI highlight the necessity

of clearly defined processes, goal-setting, and structured knowledge management to reduce uncertainty (e.g., Ihl et al. 2012; Brunswicker and Chesbrough 2018; Gentile-Lüdecke et al. 2020). Furthermore, although existing research has identified enabling factors for IOI, these insights remain fragmented—either focusing on individual firms, providing largely conceptual perspectives (e.g., O'Connor and DeMartino 2006; Boscherini et al. 2012; Bughanza and Verganti 2009), or failing to offer concrete guidance on the organizational implementation of IOI (Chiaroni et al. 2010; Huizingh 2011; Gentile-Lüdecke et al. 2020). This lack of integration underscores the need for a systematic reassessment of organizational enablers in an IOI-specific context as to date, to the best of our knowledge, there are no studies that explicitly examine the organizational enablers for implementing IOI in a holistic model. By addressing this gap, our study aims to develop an empirically grounded best practice configuration of organizational enablers that facilitate the effective implementation of IOI.

3.1 Direct effects of organizational enablers on the success of inbound open innovation projects

The adaption of new or radically new knowledge via IOI requires the coordination of various internal activities, like technology transfer and learning, knowledge sharing, evaluation etc., as well as a set of boundary-spanning activities like communication or resource sharing decisions (Hooge et al. 2016). IOI projects therefore are characterized by a high degree of uncertainty, task complexity, monitoring and coordination effort (Barbosa et al. 2021).

IOI projects require the parallel execution of a multitude of interdependent activities, people, and resources. A formal innovation process provides a systematic approach to plan and coordinate the IOI activities (Dziallas and Blind 2019). In addition, IOI projects are characterized by high uncertainty and complexity. Following specific plan-driven, problem-solving strategies help the innovation team to systematically deal with the challenges associated with uncertainty and complexity (Howell et al. 2010). Cooperative innovation projects in general and IOI projects in particular face challenges regarding the information flow between partners, the sharing of resources and opportunism (Helm et al. 2020). A formal innovation process provides a methodology to transparently organize the flow of information and resources between partners (Rönnberg et al. 2011). Furthermore, opportunism and hold-up can lead to an atmosphere of mistrust within the project. A formal innovation process helps to enable trust and cooperation by providing reliable rules for the project (Biswas and Akroyd 2016). Due to the risk of losing focus and limited resources IOI projects require clearly defined performance targets and metrics (Estrada et al. 2016). Formalized innovation processes provide a set of tools to monitor the project progress and rules to mitigate risk and to decide on the project (Brunswicker and Chesbrough 2018). The formal monitoring of the projects also helps to effectively balance resource in the overall innovation portfolio within the firm (Lerch and Spieth 2012).

Because of the above-mentioned challenges, we expect that a formalized innovation process, e.g. a dedicated, plan-driven approach including milestones, pre-determined activities, formal monitoring and risk mitigation, to execute a project

is crucial to the success of IOI (Brocke and Lippe 2015). We believe this to be true, even if there is initial evidence that IOI projects require different degrees of process formalization (Du et al. 2014; Lakemond et al. 2016; Urbinati et al. 2021). Uncoordinated activities especially in environments of high uncertainty and complexity typically lead to chaos and missed targets (Musiolik et al. 2020). Therefore, it is not a question of whether formalization is useful, but how strictly this formalization is implemented. We therefore formulate the following hypothesis:

Hypothesis 1 *A formalized inbound open innovation process has a positive effect on inbound open innovation performance.*

The execution of an IOI project requires high autonomy, intense and open communication between departments as well as openness, freedom to act and experiment, thus calling for a decentralized decision model (Gentile-Lüdecke et al. 2020; Ihl et al. 2012; Pertusa-Ortega et al. 2010). However, IOI projects must be in conformity with the objectives of the organization, assure a goal-oriented and economical execution and must be carried out with lowest possible coordination effort, in fact calling for a centralized decision model (Felin and Powell 2016; Lee et al. 2016; Will et al. 2019).

Hybrid decision models provide organizations with a self-dual structure. This means that decisions are taken from the top down, but the evaluations and views of lower levels of the organization are included in the decision process (Aghion and Tirole 1997). Therefore, hybrid decision models provide the organization with the necessary autonomy, flexibility, and openness to experiment, but assure that IOI projects are executed in line with the strategy and in a target-oriented manner (Joseph and Gaba 2020). This is a clear advantage over purely centralized or decentralized decision models which typically lead to information congestion and feelings of being excluded or overruled by higher management (Stea et al. 2015; Nieto and Mateo 2020). The integration of different hierarchy levels and functions in the decision process in hybrid decision models fosters the flow of information within the organization and increases motivation and acceptance (Reitzig and Maciejovsky 2015). The risk of non-decisions due to career risks are reduced when hierarchy takes responsibility of the decision (Baker et al. 1999). At the same time the risk of opportunism and loyalty-based decision-making is reduced when various stakeholders are included in the decision. But still, the potentially biggest advantage of hybrid decision models is better decision quality. While centralized structures tend towards conservatism and the rejection of “good” projects, because of self-reinforcing effects in sequential decision processes, polyarchic structures tend to over-optimism and the acceptance of “bad” projects in decisions due to low levels of control and critical reflection (Csaszar 2013). In hybrid decision structures, overly optimistic evaluations are checked by hierarchy and too pessimistic decisions by polyarchy in a process of mutual verification. The “noise” in hybrid decision models is found to be especially beneficial to complex decisions, since it fosters the consideration of more alternatives (Christensen and Knudsen 2010). Hybrid structures can also not only balance one error against another error, but also achieve a lower number of errors overall (Csaszar 2013). Thus, hybrid structures enable a high degree of exploration and utilization at the same time, which additionally bolsters the aforementioned (Joseph and Gaba 2020).

Due to the described shortcomings of purely centralized or decentralized decision models for the execution of IOI projects and the outlined potential benefits of hybrid decision structures, we formulate the following hypothesis.

Hypothesis 2 *The adoption of a hybrid decision-making power has a positive effect on inbound open innovation performance.*

IOI projects are typically decentralized to a certain degree and therefore need to be integrated to the core of the company. Integration is necessary since strategic goals, opportunity and risk profiles need to be calibrated, and the IOI activities need to be steered and monitored (Kretschmer and Puranam 2008). Common ways of doing this are the team-centered and individual-centered approach (Pellizzoni et al. 2019). While the team-centered approach is quite common, it has some drawbacks compared to the integration via a liaison-position (Boscherini et al. 2012; Siggelkow and Rivkin 2005).

The first big advantage of the liaison approach is more robustness to internal “noise” and as a result creating more openness compared to a team-centered approach. Committee governance structures are sensitive to interpersonal relation. Strong consensus in a committee leads to the rejection of promising projects and to a low number of projects pursued (Csaszar 2012). Liaison functions are robust to external turbulence and interference from other departments due to the high autonomy and far-reaching decision rights (Siggelkow and Rivkin 2005). The second advantage compared to committee approaches is adaptiveness. To work properly, multi-department committees typically follow formal rules and procedures to balance different interests (Egelhoff 2020). Rule-based decision systems work well in stable conditions but typically fail to adapt to quick changes in market or technology which is typical for IOI. A liaison function allows a firm to follow a balanced decision-making mode, combining hierarchical and informal decisions between the included departments and functions when properly integrated into the existing committee structures. The third advantage compared to other types of R&D integration is effectiveness. In the organization of diversified R&D departments, liaison positions are commonly used to integrate decentral units into the central R&D department (DeSanctis et al. 2002). Compared to other types of R&D integration, liaison functions follow a different way of management, e.g., stronger focus on adding experience, taking care of administration and communication, resulting in more problem-targeted innovation. In addition, liaison-positions have proven especially effective in situations with high uncertainty, large competence distance between the project and the core of the company as well as in the case of different ways of working among the partners involved in a project (Yun et al. 2016).

As has been shown, the integration of an IOI project into the core of the company is important and the commonly used team-centered approach has drawbacks, we thus formulate the following hypothesis:

Hypothesis 3 *A specialized integration role has a positive effect on inbound open innovation performance.*

While the importance of characteristics of members within the management team has been comprehensively considered in literature, it has been neglected that IOI projects require attention and engagement from top management to be successful (Chesbrough and Crowther 2006; Huizingh 2011; Rampersad et al. 2020; Tohidi et al. 2012). Due to missing consideration in literature and connotations of management commitment not going beyond “involvement” of top management (Marble 2003), we rather suggest following (Teece 2016b) with a task-oriented understanding and argue that operational management, entrepreneurship, and leadership, are the central contributions of the management team to the success of innovation projects.

IOI projects require a certain degree of operational management by the management team (Teece 2016a). Operational management aims at technical efficiency and includes all tasks and decisions related to planning, budgeting, staffing, and implementation and control of an IOI project. Operational management activities lie at the heart of strategy implementation and are the basis for central organizational outcomes like financial performance, innovation, technical and evolutionary fitness (Kor and Mesko 2012). In addition, IOI projects require entrepreneurial discretion by the management team. Entrepreneurship aims to ensure competitive advantage and differentiation through the development of new products and business models (Li et al. 2021). Entrepreneurship builds on the identification of business chances mainly by analyzing markets, competitors, and internal competencies (Datta et al. 2015). Seo and Park (2022) show that an entrepreneurial orientation leads to better learning ability and IOI performance. Furthermore, the management team needs to provide leadership to the IOI project (Augier and Teece 2009). Leadership aims at creating common purpose in the team and encompasses all tasks related to formulating and communicating a compelling vision to guide the IOI activities. Gad David et al. (2023) and Naqshbandi et al. (2019) show that empowering leadership affects absorptive capacity of a firm and thus helps to promote IOI. Involvement and engagement are subject to the intensity with which one deals with a topic. Therefore, the effect of management commitment to IOI increases with the intensity the management team engages in an IOI project. Martin (2011) confirms that management teams that formally and informally engage with high frequency in transformation projects can generate a comparable better company performance.

As outlined, IOI projects require an active and intense engagement of the management team to be executed in an effective manner. We therefore formulate the following hypothesis:

Hypothesis 4 *High commitment to an inbound open innovation project of the management team has a positive effect on inbound open innovation performance.*

3.2 Moderating effects on the enablers of inbound open innovation projects

According to Helm and Mark (2012), it is necessary to include moderator effects in an investigation for a more comprehensive understanding of cause-effect relationships. Therefore, two moderator variables high industry dynamics and number of partners have been included in the study design.

Industries with high dynamics are characterized by frequent changes in technologies, customer preferences, have a high competitive intensity and a strong technology orientation, complex products as well as short product and technology life cycles (Turulja and Bajgoric 2019). Such conditions create high uncertainties regarding the future viability of existing products and business models, create competence traps and organizational inertia (Bashir et al. 2023). Therefore, high industrial dynamics force firms to adaptability e.g., continuous, and forward-looking renewal of the knowledge base, technology competence and adjustment of the product offering and openness, but not all necessary technological developments can be covered by internal R&D (Lakhani et al. 2013). Adaptability of organizations to environmental turbulence requires flexibility and responsiveness (Schilke et al. 2018). It could be shown that strict formalization, e.g. highly formalized innovation processes does not guarantee the speed and flexibility to adapt to environmental turbulence (Mokhtarzadeh et al. 2022; Wilden et al. 2013). However, simple rules of thumb, heuristics and flexible structures have proven to give the necessary orientation in dynamic environments (Bingham and Eisenhardt 2011). We therefore propose that a formalized IOI process, e.g. a dedicated, plan-driven approach including milestones, pre-determined activities, formal monitoring etc., to execute a project, is counterproductive in situations with high industry dynamics. On the other hand, situations with high uncertainty lead managers to centralize decisions based on new information or to overrule subordinated decisions due to fear of missing out (Baker et al. 1999; Stea et al. 2015). At the same time, high uncertainty leads to hold-up strategies and slow decision-making procedures due to career risks in hybrid decision-structures, e.g. decision structures that include lower levels of the organization in the decision process (Reitzig and Maciejovsky 2015; Siggelkow and Rivkin 2005). We therefore conclude that high industry dynamics dampen the expected positive effect of hybrid decisions on IOI performance. For the same reason, we suppose that the positive effect of management commitment will be strengthened, because decision risks can be better mitigated by people with high autonomy and far-reaching decision rights. Additionally, we suppose that high industry dynamics promote the effect of specialized roles because liaison functions are robust to external turbulence and interference from other departments due to high autonomy and far-reaching decision rights, therefore combining the advantages of centralized decisions, high flexibility, and responsiveness (Siggelkow and Rivkin 2005). Thus, we formulate the following hypothesis:

Hypothesis 5 *High industry dynamics negatively moderate (H5a) the influence of a formalized innovation process, (H5b) hybrid decision-making-power, and positively moderate the influence of (H5c) specialized integration role and (H5d) management commitment on inbound open innovation performance.*

The integration of development partners in the company's internal innovation process is a fundamental prerequisite for the execution of IOI projects (Chesbrough 2003). The larger the partner network, the more opportunities for cooperation, knowledge sharing and for access to resources (Huizingh 2011). Different partners can make different contributions to an IOI project. For example, research-oriented partners can contribute complex technological knowledge to an IOI project, which is often

the basis for the development of radical innovations (Du et al. 2014). Market-oriented partners can help to improve products with respect to customer centricity. The involvement of different partners with different skills is of great importance for the success of innovation projects (Lazzarotti et al. 2011). At the same time, innovation partners differ in culture, way of working, maturity of technologies, and competence (Lyu et al. 2019). For this reason, the adapting firm requires a partner-specific collaboration and integration approach to adapt and develop technologies (Mokhtarzadeh et al. 2022). Due to the high heterogeneity of partners, technology maturities and collaboration types, we assume that formalized IOI processes, e.g. a dedicated, plan-driven approach including milestones, pre-determined activities, formal monitoring, and risk mitigation to execute a project are counterproductive in situations with a high number of partners. In addition, a high number of partners in an IOI project leads to complexity, high coordination efforts, and information overload (Abhari et al. 2018). This slows down decisions and business processes in hybrid decision structures, e.g. decision structures that include lower levels of the organization in the decision process, mainly due to high coordination efforts (Egelhoff 2020; Felin and Powell 2016). In addition, in situations with many innovation partners, decisions may be delayed, avoided or counterproductive due to lack of alignment, oversight, or career risks because of high uncertainties in hybrid decision structures (Reitzig and Maciejovsky 2015). Therefore, we suppose that a high number of partners dampens the positive effect of hybrid decision structures since complexity, information overload, hold-up, and contradictory decisions can be better resolved in centralized decision structures. For the same reason, we suppose that the positive effect of management commitment will be strengthened in situations with many partners, because decision risks can be better mitigated by people with high autonomy and far-reaching decision rights. Additionally, we suppose that the effect of a specialized role will be strengthened in situations with many partners, because liaison functions are robust to external turbulence and interference from other departments, therefore combining the advantages of centralized decisions, high flexibility, and responsiveness (Siggelkow and Rivkin 2005). Thus, we formulate the following hypothesis:

Hypothesis 6 *A high number of innovation partners negatively moderate the influence of (H6a) a formalized innovation process, (H6b) a hybrid decision-making-power, and positively moderate the influence of (H6c) specialized role and (H6d) management commitment on inbound open innovation performance.*

The hypotheses approach as well as the corresponding results are summarized in Fig. 1 in Sect. 5.2.

4 Methodology and data

4.1 Method

We applied multivariate regression models to analyze the relationship between the identified enablers and IOI performance. A sample consisting of manufacturing com-

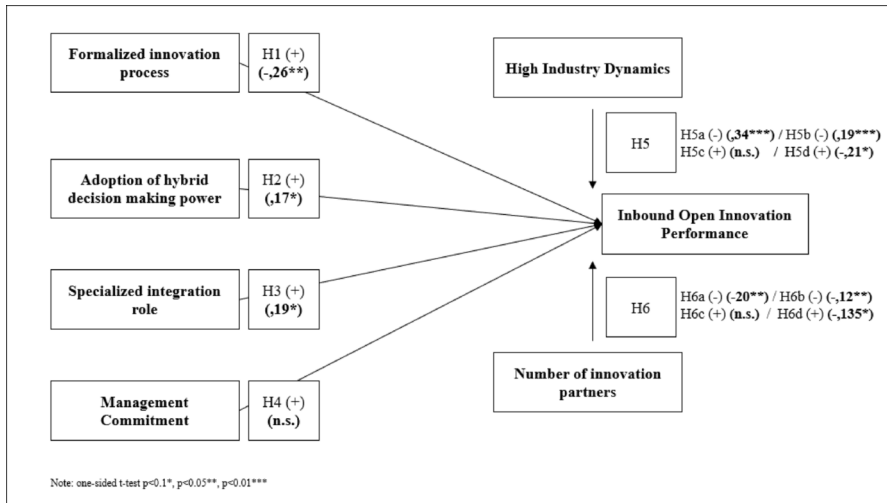


Fig. 1 Hypotheses approach

panies in Germany with more than 250 employees is used for this paper. Due to the rigorous definition of IOI projects this results in a sample size of $n=73$. SPSS was used to perform the factor, regression, and moderation analysis.

4.2 Data sample

To ensure that a single IOI project is only included once in the dataset, care was taken to ensure that each company was only contacted once. The theoretically required sample size with a mean effect size and 4 or 6 predictors and a statistical power of 0.95 is 111 cases. With the actual sample size of 73 with 3 or 4 predictors, an assumed mean effect size of 0.09, the statistical power is 0.845 (Cohen 1992). Because of the reasonable deviation in terms of statistical power and representative random sample generation, it can be assumed that representative results can be generated even with a relatively small sample (Prein et al. 1994).

To obtain data about intrafirm or interfirm processes, the use of key informants is common (Gruber et al. 2010), but common method variance can bias the relationships between variables measured with self-reported surveys. Although previous warnings might have tended to exaggerate this problem (Schaller et al. 2015), we still checked for potential common method variance using the MacKenzie and Podsakoff (2012) recommended procedures. First, we relied solely on survey data since it is not possible to separate project attributes from performance. Second, we formulated the questions in the survey as precisely as possible. Third, we separated the questions pertaining to the dependent variables from those related to the independent variables. Fourth, we guaranteed the respondents' anonymity. Fifth, we used a pretest to confirm the comprehensibility of the questions before we conducted the survey. Sixth, the analysis including moderating effects led to greater complexity and reduced the potential effects of respondents' implicit theories (Siemsen et al. 2010). Moreover, we employed a marker variable approach to detect common method bias (Vahter et

al. 2014). This technique compares pairwise correlations of the key variables in the data set. The marker variable should be theoretically unrelated to at least one variable in the study. We tested the innovation process variable; its lowest correlation arises with R&D ratio. We take this correlation as a measure of common method bias and subtract it from the other pairwise correlations; however, doing so does not considerably affect the correlations between the variables that we use in the analysis. Thus, the marker variable test indicates that common method variance is not a serious concern. Normal distribution can be confirmed based on inferential statistical methods, e.g., Kolmogorov–Smirnov, Shapiro–Wilkow and visual tests (Field 2018).

4.3 Measures

For the operationalization of the constructs, proven measurements from the literature are used. For the measurement of innovation performance, we use a subjective, i.e. non-objective measurement in the form of a reflective measurement model. In this way, a high validity of the constructs shall be ensured and biases in the measurement results shall be avoided (Hosseini and Owlia 2016). The measurement items for the variables and the selected controls are presented in the “Appendix”. A multi-item design is used to measure the identified constructs using a 7-point Likert scale (Diamantopoulos et al. 2012). To ensure the stability and significance of the results, control variables such as R&D intensity and size are included in the study (Poehlmann et al. 2021).

We use confirmatory (CFA) factor analysis to confirm reliability and validity of the constructs. After 12 iterations the factor analysis results in a five-factor solution with clear loadings (Table 1).

The factor loadings of the dependent and independent variables as well as the moderators are medium to high (≥ 0.5) (Huang and Chen 2017). The results of the CFA show decent indicator reliability with $SMC > 0.4$, good factor reliability with $C.R. > 0.6$, and Cronbach’s $\alpha > 0.7$ (Li et al. 2021; Tohidi et al. 2012). The AVE is below but close to the recommended value of 0.5 for all constructs (Markovic et al. 2020). The factor correlations obtained in combination with a test by the Fornell and Larcker (1981) criterion point to discriminant validity. AVE values do not support convergent validity, however, due to the high correlations between the items per construct and comparable values in the reference studies of the constructs used, it can be assumed that this criterion is also fulfilled. An additionally performed χ^2 difference test also confirms discriminant validity and high model quality since a difference of 20.65 between the restricted and non-restricted model could be measured and as the quotient of χ^2 and d.f. is below 3 (Tohidi et al. 2012). Since the constructs and indicators have been derived soundly from theory and only a moderate violation of one quality criterion can be observed, an acceptable to good reliability and suitability of the manifest variables for the main investigation can be assumed (Naqshbandi et al. 2019).

Table 1 Factor analysis

Independent variable	Items	Loadings	SMC	Cronbach-Alpha	C.R	AVE
Innovation process	IP1	0.566	0.320	0.791	0.766	0.399
	IP2	0.536	0.287			
	IP3	0.662	0.438			
	IP5	0.714	0.510			
	IP6	0.661	0.437			
Decision making power	DMP1	0.654	0.428	0.821	0.828	0.446
	DMP2	0.585	0.342			
	DMP3	0.748	0.560			
	DMP4	0.675	0.456			
	DMP5	0.681	0.464			
Specialized role	DMP6	0.652	0.425	0.740	0.717	0.391
	SP1	0.517	0.267			
	SP2	0.633	0.401			
	SP3	0.630	0.397			
	SP4	0.706	0.498			
Management commitment	MC1	0.639	0.408	0.774	0.736	0.414
	MC2	0.655	0.429			
	MC3	0.722	0.521			
	MC4	0.544	0.296			
<i>Moderator variable</i>						
High industry dynamics	DYI1	0.764	0.584	0.892	0.873	0.535
	DYI2	0.659	0.434			
	DYI3	0.842	0.709			
	DYI4	0.677	0.458			
	DYI5	0.649	0.421			
	DYI6	0.778	0.605			
Number of partners	NOP1	0.785	0.616	0.763	0.685	0.427
	NOP2	0.523	0.274			
	NOP3	0.626	0.392			
<i>Dependent variable</i>						
Inbound-performance	PERF1	0.818	0.669	0.744	0.763	0.457
	PERF2	0.669	0.448			
	PERF3	0.728	0.53			
	PERF4	0.426	0.181			

5 Results

5.1 Descriptive analysis

Table 2 shows the descriptive statistics and correlations. The companies in the sample are primarily large, established companies with low to medium research intensity. Approximately 18% of the study participants have employed more than 5000 employees in the last three years. Regarding the research intensity of the companies, it should be noted that a large proportion account for medium research intensity with a R&D-Ratio between 2.5 and 7% (Rammer 2011). The IOI projects referenced in this study also predominantly have an engineering focus, followed by a manufactur-

Table 2 Descriptive statistics and factor correlations

	1	2	3	4	5	6	7	8	9
1. Inbound- Performance (PERF)	–								
2. R&D ratio	0.300*	–							
3. Number of employees	0.172	0.089	–						
5. High Industry Dynamics (DYI)	0.203*	0.426**	0.401**	–					
6. Number of Partners (NOP)	0.385**	0.174	0.383**	.575**	–				
7. Innovation Process (IP)	0.194	0.032	0.22	0.421	0.488	–			
8. Decision Making Power (DMP)	0.230*	0.22	0.137	0.191	0.203*	0.275**	–		
9. Specialized Role (SP)	0.241*	0.106	0.275*	0.255*	0.439**	0.284**	0.189	–	
10. Man- agement Commitment (MC)	0.127	–0.037	0.144	0.384**	0.378**	0.438**	0.220*	0.366**	–
Mean	4.280	0.069	9245.9	5.026	4.888	5.752	2.947	4.957	5.492
Standard deviation	1.285	0.127	24,592.8	1.190	1.383	.917	1.374	1.109	0.965

ing or natural science focus. The experience of the companies in the implementation of IOI projects is low. In approximately 66% of the cases, only up to five IOI projects were carried out. The low experience is in line with research on the context of IOI, which shows, that IOI is highly context specific.

5.2 Regression analysis

To test the hypotheses, including the interaction effects, stepwise regression analysis was performed in SPSS 28.0 for each independent variable (Chang et al. 2012). PROCESS by Hayes (2013) was used to validate the interaction effects. The descriptive statistics in Table 2 show moderate correlations among the moderator and control variables and the independent variables in the model. VIF values are close to 1, ranging between 1.098 and 1.692 for Models 1–3 in Table 3, thus suggesting no problems with multicollinearity (Bapuji et al. 2011).

We mean-centered all variables of the interaction terms to reduce potential multicollinearity problems between the main and the interaction variable in the regression models (Aiken et al. 1991). The model premises with respect to linearity and homoscedasticity have been tested with a Tukey-Anscombe plot and a Breusch-Pagan test. The Breusch and Pagan (1979) test confirms homogeneous error variances for the model with a Chi-Squared of 0.262, df. 1 and $p=0.609$. Furthermore, a modified

Table 3 Regression results

Dependent variable: inbound open innovation-performance N=73											
	Model 0 (control)	Model 1 (direct effect)	Model 2 (mod- erator variable)	Model 3 (DYI*IP)	Model 4 (DYI*DMP)	Model 5 (DYI*SP)	Model 6 (DYI*MC)	Model 7 (NOP*IP)	Model 8 (NOP*DMP)	Model 9 (NOP*SP)	Model 10 (NOP*- MC)
Intercept	3.970	2.031	2.608	2.120	3.568	2.668	1.944	4.084	5.143	4.393	4.082
Main effects											
Innovation process		0.108		-0.269**	-0.145	-0.032	-0.043	-0.195	-0.082	-0.060	-0.031
Decision making power		0.172*		0.129*	0.217***	0.156**	0.157**	0.134*	0.193**	0.173**	0.143*
Specialized role		0.188*		0.183	0.071	0.080	0.138	0.147	0.057	0.095	0.083
Management commitment		-0.024		-0.149	-0.113	-0.070	-0.175	-0.113	-0.119	-0.043	-0.164
High industry dynamics											
DY1 * IP				-0.343***							
DY1 * DMP					-0.199***						
DY1 * SP						0.077					
DY1 * MC							-0.211**				
Number of partners											
NOP * IP								-0.202**			
NOP * DMP									-0.119**		
NOP * SP										0.107	
NOP * MC											-0.135*
Controls											
R&D ratio	0.218*										
Number of employees	0.197										
Moderators											

Table 3 (continued)

Dependent variable inbound open innovation-performance N=73											
	Model 0 (control)	Model 1 (direct effect)	Model 2 (mod- erator variable)	Model 3 (DYIxIP)	Model 4 (DYIxDMP)	Model 5 (DYIxSP)	Model 6 (DYIxMC)	Model 7 (NOPxIP)	Model 8 (NOPxDMP)	Model 9 (NOPxSP)	Model 10 (NOPx- MC)
High industry dynamics			-0.027	-0.093	-0.013	-0.017	-0.081	-0.036	0.005	-0.023	-0.078
Number of partners			0.400***	0.377***	0.384**	0.347***	0.312***	0.360***	0.347***	0.354***	0.376***
R ²	0.073	0.103	0.149	0.273	0.223	0.187	0.219	0.210	0.209	0.197	0.197
ΔR ²	-	-	-	0.093	0.043	0.007	0.039	0.030	0.029	0.017	0.017
F-Statistic	2.761*	1.946*	6.108***	6.499***	3.613***	2.617**	4.416***	4.480***	3.225***	2.488**	4.505***
*p<0.1 **p<0.05; ***p<0.01											

* $p < 0.1$ ** $p < 0.05$; *** $p < 0.01$

Significance tests are one-tailed for hypothesized relations and two-tailed for controls

Breusch-Pagan test and a White test on heteroscedasticity were conducted. Neither test was significant which indicates that there is no evidence of a linear or non-linear functional relationship between the predictors and the variances of the residuals. Due to the relatively small sample size, parameter estimates with robust standard errors (Hayes and Cai 2007) were additionally calculated. The results in Table 4 show that even in the case of heteroscedasticity the model is robust.

The results of the regression analysis can be found in Table 3. Models 0 and 2 are the baseline, i.e. they only contain control variables and the two moderators. Model 1 is the main model and investigates the effect of the four independent variables innovation process (IP), decision-making-power (DMP), specialized role (SP) and management commitment (MC) on IOI performance. Models 3 to 10 examine the moderation effects of high industry dynamics and the number of innovation partners on the four independent variables. Starting with the control variables in Model 0 we find a significant positive effect of R&D ratio ($\beta=0.22$, $p<0.1$) on IOI performance. Number of employees shows a positive but not significant effect ($\beta=0.19$, n.s.). Model 2 shows that high industry dynamics ($\beta=-0.27$, n.s.) has a negative but not significant effect and that number of innovation partners ($\beta=0.40$, $p<0.01$) has a highly significant effect on IOI performance.

Regarding the main effects Model 1 shows that the four variables account for about 10% of the variance in the model. Hypothesis 1 predicts that innovation process is positively related to IOI performance and cannot be supported by Model 1 ($\beta=0.10$, n.s.). Nevertheless, Model 3 ($\beta=-0.27$, $p<0.1$) shows a significant negative effect for innovation process when industry dynamics are high. A marginal effect analysis (see Fig. 6 in the “Appendix”) confirms a significant negative direct effect of innovation process found in Model 3 (Busenbark et al. 2022). Thus, Hypothesis 1 is not supported. Hypothesis 2 which forecasts a positive relation between hybrid decision-making-process and IOI performance can be supported by Model 1 ($\beta=0.17$,

Table 4 Parameter estimates with robust standard errors

Model 1 (direct effect) N=73		
	Standard error	Robust standard error
Intercept	2.031	2.031
<i>Regression</i>		
Innovation process	0.108 n.s., $p=0.203$ $\pm=0.181$	0.108 n.s., $p=0.1475$ rob. $\pm=0.144$
Decision making power	0.172* $p=0.079$ $\pm=0.113$	0.172** $p=0.049$ rob. $\pm=0.096$
Specialized role	0.188* $p=0.069$ $\pm=0.145$	0.188* $p=0.0865$ rob. $\pm=0.158$
Management commitment	-0.024 n.s., $p=0.428$ $\pm=0.176$	-0.024 n.s., $p=0.4465$ rob. $\pm=0.239$
R ²	0.103	0.103
F-Statistic	1.946* $p=0.0565$	1.946* $p=0.0565$

* $p<0.1$ ** $p<0.05$; *** $p<0.01$

Significance tests are one-tailed for hypothesized relations and two-tailed for controls

$p < 0.01$). The significant effect can be confirmed by Model 3–10 and is especially pronounced when industry dynamics ($\beta = 0.21$, $p < 0.01$) and number of partners ($\beta = 0.1$, $p < 0.05$) is high. Thus Hypothesis 2 is supported. Hypothesis 3 suggests a positive relation of specialized role and IOI performance and is supported by Model 1 ($\beta = 0.18$, $p < 0.1$). Nevertheless, Models 3–10 do not show a significant effect of specialized role. A test for non-linearity shows a significant quadratic trend that a specialized role ($\beta = 0.23$, $p < 0.1$) has on IOI performance. Thus, Hypothesis 3 can only be partially supported. Hypothesis 4 argues a positive relation of management commitment and IOI performance. Model 1 ($\beta = -0.02$, n.s.) and the other models show a negative but not significant relation. Thus, Hypothesis 4 is not supported.

Hypothesis 5 predicts that the effect of the independent variables on IOI performance is moderated by high industry dynamics. Model 3 confirms the expected negative moderation effect of innovation process ($\beta = -0.34$, $p < 0.01$) in Hypothesis 5a on IOI performance when industry dynamics are high. In addition, the simple slope analysis shows that the negative moderation effect of innovation process formalization is lower in situations with low industry dynamics. Thus, Hypothesis 5a can be supported. Hypothesis 5b which forecasts a negative moderation effect of high industry dynamics on hybrid decision-making-power ($\beta = -0.19$, $p < 0.01$) is confirmed by Model 4. Thus, Hypothesis 5b can be supported. Model 5 shows that the significant positive moderation effect of high industry dynamics on specialized integration role ($\beta = 0.07$, n.s.) expected in Hypothesis 5c cannot be found. Hence, Hypothesis 5c cannot be supported. We controlled for non-linearity with respect to IOI performance and found an interesting significant effect for specialized integration role ($\beta = 0.23$, $p < 0.1$). Model 6 gives no evidence ($\beta = -0.21$, $p < 0.05$) to support Hypothesis 5d, which predicts a positive moderation effect of high industry dynamics on management commitment. In fact, Hypothesis 5d cannot be supported. We additionally present the two-way interactions in Figs. 2 and 3 in the “Appendix”.

Hypothesis 6 predicts that the effect of the independent variables on IOI performance is moderated by number of innovation partners. Model 7 does support Hypothesis 6a which forecasts a negative moderation effect of formalized innovation processes ($\beta = -0.20$, $p < 0.05$) on IOI performance when the number of partners is high. Thus, Hypothesis 6a can be supported. Model 8 shows evidence for the expected negative moderation effect of number of partners ($\beta = -0.11$, $p < 0.05$) on hybrid decision-making-power. Hence, Hypothesis 6b can be supported. Model 9 ($\beta = 0.10$, n.s.) does not support the expected positive interaction of number of partners and specialized integration role predicted in H6c. In fact, Hypothesis 6c cannot be supported. Finally, Model 10 does not prove the expected positive moderation effect of number of partners on management commitment ($\beta = -0.14$, $p < 0.1$) in Hypothesis 6d. Thus, Hypothesis 6d cannot be supported. Figure 1 summarizes the hypotheses approach explained in Chapter 3 as well as the corresponding results. We additionally present the two-way interactions for Hypothesis 6 in Figs. 4 and 5 in the “Appendix”.

6 Discussion

6.1 General discussion

Hypothesis 1 revealed a negative effect of formalized IOI processes on IOI performance. While prior research highlights the benefits of formalized IOI processes (Ihl et al. 2012; Brunswicker and Chesbrough 2018; Gentile-Lüdecke et al. 2020) our findings indicate that these structured, plan-driven approaches fail to accommodate the uncertainty and complexity inherent in IOI. As specifically evidenced by the findings regarding Hypothesis 5a and 6a, particularly in environments with a high number of innovation partners and dynamic industry conditions, rigid structures may impede adaptability and responsiveness. This aligns with studies suggesting that radical and OI projects necessitate more flexible governance models that allow for iterative adjustments to milestones, goals, and resource allocation (Chiesa et al. 2009; Kelley 2009; Miles et al. 2009; Lakhani et al. 2013; Felin and Powell 2016).

Hypothesis 2 examined whether the use of a hybrid decision-making authority has a positive effect on IOI performance. The results suggest that hybrid structures, characterized by hierarchical oversight combined with cross-functional involvement, enhance IOI outcomes by improving decision quality, fostering acceptance, and ensuring better information flow across organizational levels. These findings support previous research emphasizing the importance of cross-functional collaboration and integrative governance in knowledge-intensive innovation contexts (De Clercq et al. 2011; Joseph and Gaba 2020). However, following the results obtained for Hypothesis 5b and 6b, the study also revealed boundary conditions: under high industry dynamics, hybrid decision-making structures may slow down decision processes, mirroring prior observations on decision inertia in uncertain environments (Siggelkow and Rivkin 2005; Reitzig and Maciejovsky 2015). Similarly, when the number of innovation partners increases, hybrid structures can contribute to information overload and decision congestion, reinforcing earlier findings on the complexity of managing multi-partner collaborations.

Hypothesis 3 explored the extent to which a specialized integration role has a positive effect on IOI performance. Our findings suggest that this role functions as a stabilizing mechanism, mitigating inefficiencies inherent in committee governance. By bridging centralized and decentralized organizational areas, a specialized integration role effectively manages coordination challenges arising from organizational entropy and misaligned goals. This supports prior research emphasizing the advantages of liaison functions in balancing strategic alignment and operational flexibility (Boscherini et al. 2012; Siggelkow and Rivkin 2005). However, our findings also indicate that excessive independence and autonomy within a specialized integration role can negatively impact IOI performance. If not properly integrated into the company's information and committee cascade, high levels of decentralization may lead to misalignment with corporate objectives and reduced coordination efficacy. To counteract these risks, firms must ensure that the specialized integration role is embedded within existing governance structures while maintaining sufficient autonomy to facilitate responsiveness (Egelhoff 2020).

Summarizing the results, the study shows that IOI has many similarities with radical innovation and few similarities with incremental innovation. IOI projects are

associated with a high degree of novelty, uncertainty, and complexity for the adapting organization and require situation-specific, flexible organizational structures and governance. The results of this study support the widely accepted view that IOI calls for dynamic capabilities, e.g. a company-specific but descriptive and transferrable routine that emerges from experience (Carmona-Lavado et al. 2021; El Maalouf and Bahemia 2023).

6.2 Theoretical contribution

First, this study appears to be among the first to provide theoretically grounded, empirical research focused on specific organizational enablers for IOI as defined in a narrow, literature-supported manner. By refining the scope to examine enablers within this highly specific context, we lay the foundation for understanding IOI as a targeted process that can be systematically managed and shaped. While prior research has highlighted the complexity and distinct governance challenges of IOI (Huizingh 2011; West and Bogers 2014; Chesbrough 2024), few studies have provided a structured analysis of the role of organizational enablers in this domain. Our study addresses this gap by not only refining the conceptualization of IOI enablers but also by introducing a set of constructs for measuring their effects on IOI performance. This empirical confirmation of theoretical assumptions contributes to a more nuanced understanding of organizational design choices in IOI (Boscherini et al. 2012; Bianchi et al. 2016; Gentile-Lüdecke et al. 2020; El Maalouf and Bahemia 2023). Moreover, recent calls for research have emphasized the need for a more granular exploration of how firms structure and govern IOI projects (e.g., Gentile-Lüdecke et al. 2020), underscoring the relevance of our study within the broader discourse on innovation governance. Additionally, our study deliberately focuses on German manufacturing firms, a context characterized by high technological intensity, advanced innovation ecosystems, and strong traditions of structured collaboration in innovation networks (Rammer et al. 2024). This choice is not only justified by these characteristics, but also by methodological considerations: a geographically and institutionally consistent research context helps control for potential confounding factors, such as cultural influences, which might otherwise distort the identified effects. Moreover, German manufacturing firms are at the forefront of digital transformation, particularly in the context of digital product-service systems and Industry 4.0, where platform-based business models and data-driven innovation increasingly shape interfirm collaboration (Veile et al. 2022; Soellner et al. 2024). These developments further reinforce the relevance of this context for studying IOI, as firms must navigate the interplay between digital ecosystems, external knowledge integration, and governance mechanisms. By examining IOI governance within this highly developed and structured innovation environment, our study offers insights that can inform IOI practices in similarly complex, technology-intensive industries. While our focus is deliberately narrow to ensure conceptual clarity, our findings complement broader, less context-specific discussions on IOI by illustrating how targeted governance mechanisms operate in environments where firms must balance collaboration with strategic control.

Second, the study contributes to a more comprehensive understanding of the “organizational design” of different innovation projects by identifying the suitability of different organizational configurations in terms of requirements and framework conditions. Furthermore, our findings highlight that explanatory approaches that do not account for project-specific conditions risk oversimplification. This aligns with calls for a more differentiated perspective that accounts for the distinct structural and managerial demands of various innovation types (West and Bogers 2014; El Maalouf and Bahemia 2023). By adopting a project-level perspective, our study provides empirical insights into how governance mechanisms operate in IOI settings, offering implications for both theory and practice in the fields of organization theory, OI management, and collaboration dynamics.

Third, our findings underscore the need for a stronger consideration of individual roles and behaviors in IOI theory. Existing research predominantly examines IOI through an organizational and structural lens (West and Bogers 2017; Gentile-Lüdecke et al. 2020; Carmona-Lavado et al. 2021), often overlooking the agency of individuals in shaping innovation outcomes. While some studies have analyzed the characteristics of individuals involved in IOI (Pellizzoni et al. 2019), there remains a gap regarding how their roles and decision-making behaviors influence project success. Our study responds to this gap by demonstrating that IOI performance is contingent on the ability of individuals to dynamically adapt structures to changing conditions and manage high levels of uncertainty—an aspect that warrants further theoretical integration.

6.3 Practical implications

Technological progress presents companies with challenges that can rarely and, in addition more efficiently be managed exclusively with “on-board” resources and in-house developments. Therefore, it is advisable to conduct inbound projects in environments with already established innovation ecosystems or in industries with distributed development structures. Beyond technological considerations, successful IOI also depends on aligning organizational structures, cultural readiness, and strategic intent (Saeed et al. 2015; Naqshbandi et al. 2019; Joseph and Gaba 2020; Gad David et al. 2023). Hence, companies should foster an open organizational culture that supports cross-boundary collaboration, knowledge-sharing, and risk-taking, as these factors are critical for sustaining IOI initiatives.

When conducting IOI projects, flexible ad-hoc project steering and decisions on project level outperform formal structures and decision models. Therefore, it is recommended to entrust a member of the senior management team with the steering of the project. This recommendation is obviously dependent on the specific management structure of a focal company. The combination of these two organizational elements constitutes a governance model superior to traditional committee structures by enabling the organization to make better-informed decisions and increasing the IOI project's ability to react and act in turbulent situations and enabling the project team to concentrate on operational tasks.

A formal innovation process such as those used for incremental innovation projects may not work well for IOI. Therefore, the manager in charge must be aware

and capable of adjusting the governance to the specific needs of the project. Additionally, organizations should ensure that knowledge gained from past IOI projects is systematically captured and shared. Due to the lack of standardization, it makes sense to create a company-wide accessible knowledge repository with best practices and guidelines for the governance of IOI projects, incorporating not only technological insights but also organizational and strategic learnings to support long-term IOI success.

6.4 Conclusion, limitations, and future research

Despite growing interest in IOI, existing research remains fragmented, with contradictory findings on its implementation and a lack of holistic, empirically validated insights into intra-organizational enablers (Burcharth et al. 2014; Hossain et al. 2016; West and Bogers 2017; Bogers et al. 2018, 2019; Tiberius et al. 2021). While some studies emphasize flexibility and decentralization (Miles et al. 2009; Felin and Powell 2016; Schmidt and von der Oelsnitz 2020), others highlight the need for structured processes, goal-setting, and knowledge management to reduce uncertainty (Ihl et al. 2012; Brunswicker and Chesbrough 2018; Gentile-Lüdecke et al. 2020), yet without integrating these perspectives into a comprehensive framework. Addressing this gap our study provides an empirically grounded best-practice configuration of organizational enablers, offering concrete guidance for the effective implementation of IOI. To contribute to this, the main objective was to identify, empirically test and validate intra-organizational enablers for IOI within a theoretically grounded framework. Consequently, an empirical study based on a dataset of manufacturing companies in the highly innovation-intensive location Germany was performed. We identified hybrid decision-making structures and a specialized integration role as enablers for IOI, while formalized innovation processes have proven counterproductive. High industry dynamics and the number of innovation partners are significant moderators.

The enablers examined in this study, along with their associated metrics, exhibit solid reliability and validity, having been rigorously derived from theory using a structured literature review. Nevertheless, expanding and refining the list of enablers would be particularly valuable, with one promising starting point being the capabilities for external technology procurement identified in capability research (El Maalouf and Bahemia 2023). Moreover, redefining the search terms could reveal alternative enablers, which should then be empirically tested for their impact on innovation performance.

Additionally, the study's scope is inherently limited by its focus on Germany, a country characterized by high innovation intensity and an advanced innovation ecosystem. While the robustness of our findings is supported by extensive testing, the relatively small sample size suggests that future research could expand or refine the geographical scope, either by including additional countries or by concentrating on those with comparable innovation conditions rather than Germany's specific context.

Moreover, our study found that a high commitment to an IOI project by the management team was insignificant regarding IOI performance. One factor that could explain this insignificance is the presence of varying management capabilities and competencies among the sample, which are essential for a positive impact on IOI performance (Chesbrough 2024). Furthermore, because of high correlations between management commitment, the innovation process, and the specialized role, as shown

in Table 2, reconsidering the variable in a different setup could yield different results, since it can be assumed that the outlined tasks are largely substituted by the specialized integration role and hybrid decision-making structures.

The study has shown that a formal innovation process has a significant negative impact on IOI performance, but under certain conditions, e.g. low industry dynamics, formalization can be beneficial to reduce complexity in an IOI project. Therefore, future research should consider how situation-specific governance models for IOI could be designed. Reconsidering the variable in a different setup could yield in guidelines for IOI processes and help scale IOI projects and transfer best practices between companies.

Lastly, we found a significant negative moderation on the effects of hybrid decision making structures and management commitment on IOI performance when industry dynamics and the number of innovation partners are high. This finding is interesting and deserves further consideration, since it suggests that turbulent environmental conditions require centralized decisions but at the same time no strong leadership, as high management commitment can lead to free-riding and low employee commitment (e.g., employees do not actively participate in the project due to the strong, active role of top management).

Appendix

See Figs. 2, 3, 4, 5, 6 and 7.

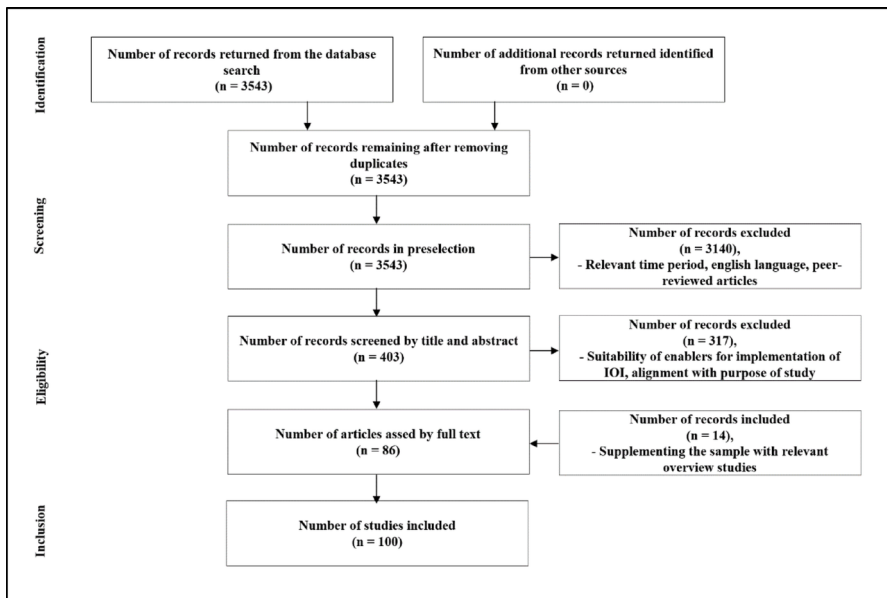


Fig. 2 Literature review process

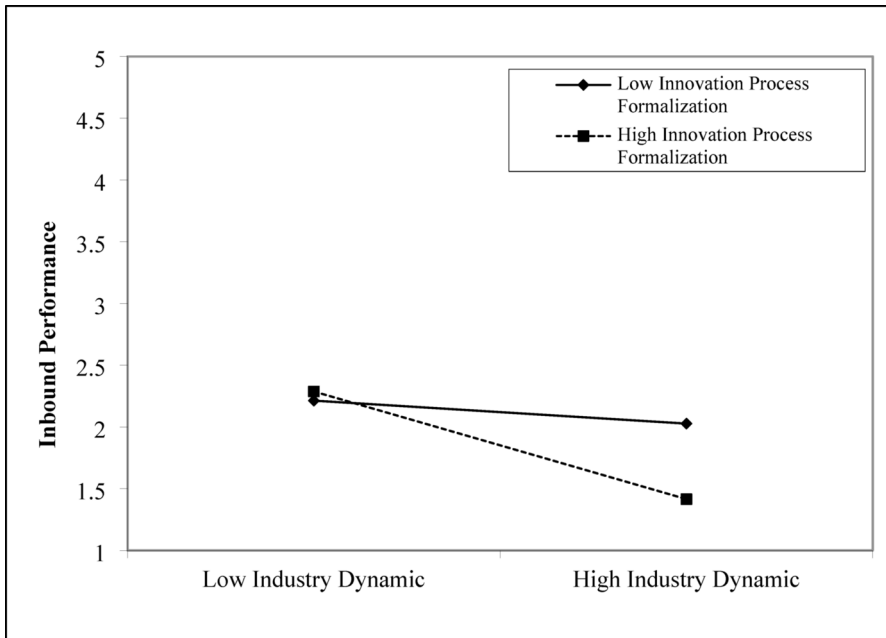


Fig. 3 DYI x IP

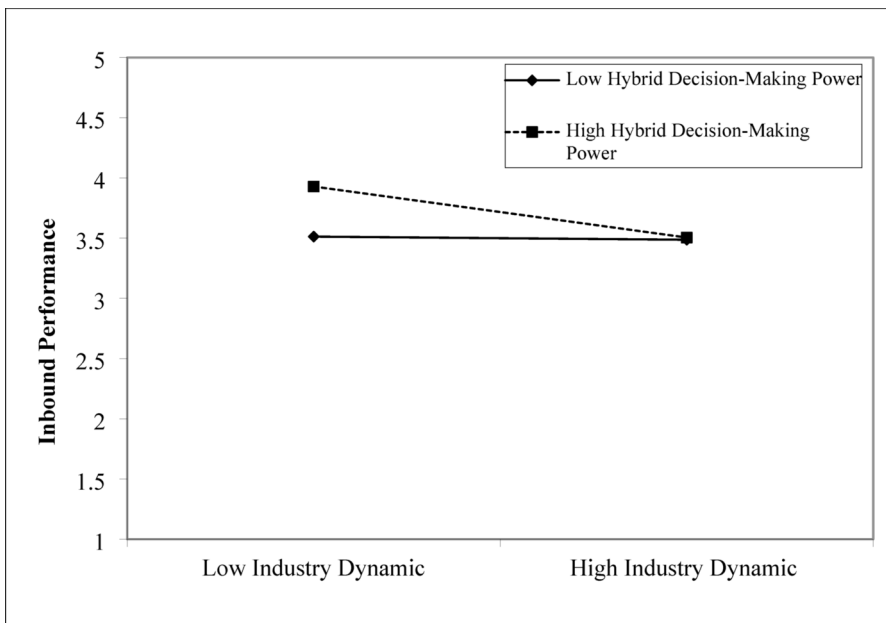


Fig. 4 DYI x DMP

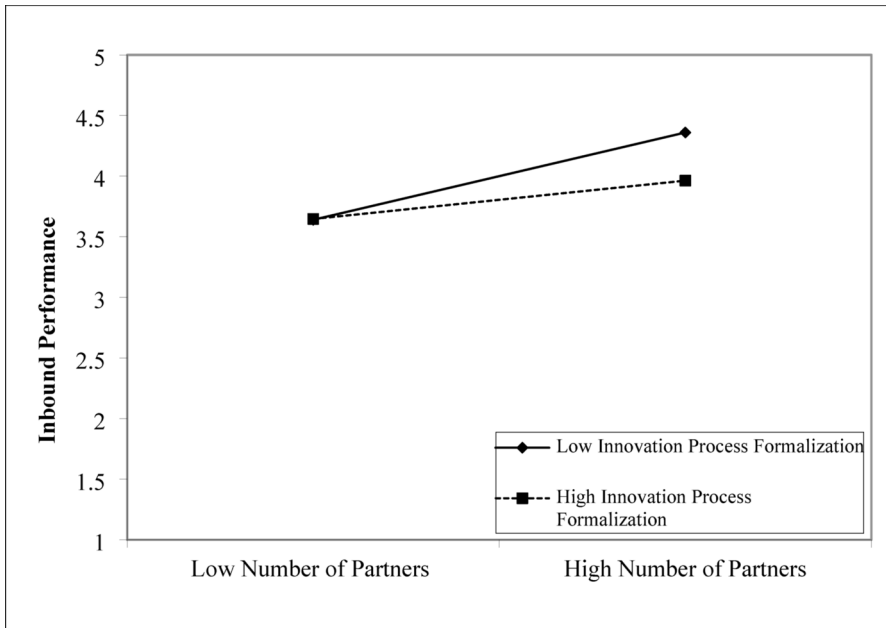


Fig. 5 NOP x IP

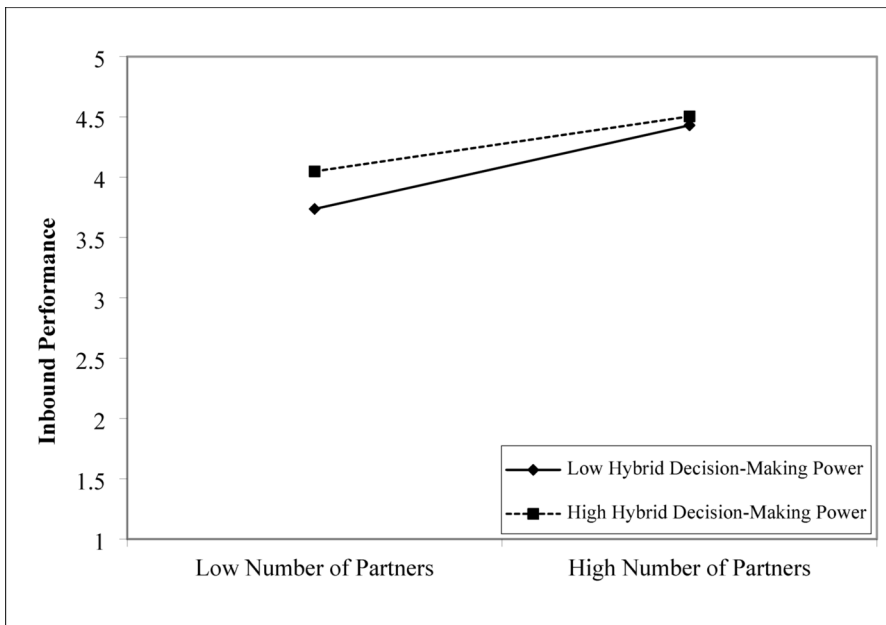


Fig. 6 NOP x DMP

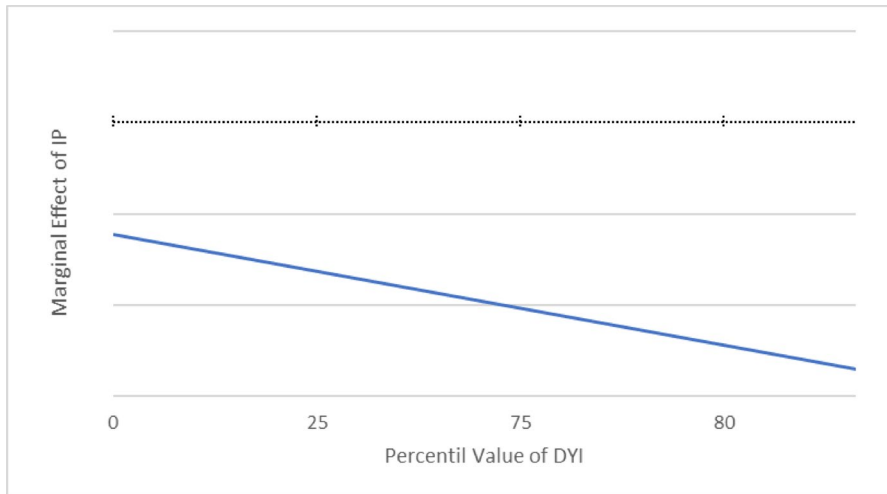


Fig. 7 Marginal effect DYI x IP

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References

- Abhari K, Davidson EJ, Xiao B (2018) A risk worth taking? The effects of risk and prior experience on co-innovation participation. *Internet Res* 28(3):804–828. <https://doi.org/10.1108/IntR-05-2017-0196>
- Aghion P, Tirole J (1997) Formal and real authority in organizations. *J Political Econ* 105(1):1–29. <https://doi.org/10.1086/262063>
- Ahn JM, Minshall T, Mortara L (2017) Understanding the human side of openness: the fit between open innovation modes and CEO characteristics. *R&D Manag* 47(5):727–740. <https://doi.org/10.1111/rdm.12264>
- Aiken LS, West SG, Reno RR (1991) Multiple regression: testing and interpreting interactions. Sage Publishing, Beverley Hills
- Alexy O, Bascavusoglu-moreau E, Salter AJ (2016) Toward an aspiration-level theory of open innovation. *Ind Corp Change* 25(2):289–306. <https://doi.org/10.1093/icc/dtw003>
- Arora A, Gambardella A (2010) Ideas for rent: an overview of markets for technology. *Ind Corp Change* 19(3):775–803. <https://doi.org/10.1093/icc/dtq022>
- Augier M, Teece DJ (2009) Dynamic capabilities and the role of managers in business strategy and economic performance. *Organ Sci* 20(2):410–421. <https://doi.org/10.1287/orsc.1090.0424>
- Baker G, Gibbons R, Murphy KJ (1999) Informal authority in organizations. *J Law Econ Organ* 15(1):56–73. <https://doi.org/10.1093/jleo/15.1.56>

- Bapuji H, Loree D, Crossan M (2011) Connecting external knowledge usage and firm performance: an empirical analysis. *J Eng Technol Manag* 28(4):215–231. <https://doi.org/10.1016/j.jengtecman.2011.06.001>
- Barbosa AP, Salerno MS, Nascimento PT, Albala A, Maranzato FP, Tamoschus D (2021) Configurations of project management practices to enhance the performance of open innovation R&D projects. *Int J Proj Manag* 39(2):128–138. <https://doi.org/10.1016/j.ijproman.2020.06.005>
- Bashir M, Alfalih A, Pradhan S (2023) Managerial ties, business model innovation & SME performance: moderating role of environmental turbulence. *J Innov Knowl* 8(1):100329. <https://doi.org/10.1016/j.jik.2023.100329>
- Bauer U, Endres H, Dowling M, Helm R (2018) Organisational capabilities for technology transfer: a study of R&D-intensive firms in Germany. *Int J Innov Manag* 22(4):1850041-1–1850041-31. <https://doi.org/10.1142/S136391961850041X>
- Bianchi M, Croce A, Dell'Era C, Di Benedetto CA, Frattini F (2016) Organizing for inbound open innovation: how external consultants and a dedicated R&D unit influence product innovation performance. *J Prod Innov Manag* 33(4):492–510. <https://doi.org/10.1111/jpim.12302>
- Bingham CB, Eisenhardt KM (2011) Rational heuristics: the ‘simple rules’ that strategists learn from process experience. *Strateg Manag J* 32(13):1437–1464. <https://doi.org/10.1002/smj.965>
- Biswas S, Akroyd C (2016) The governance of inter-firm co-development projects in an open innovation setting. *Pac Account Rev* 28(4):446–457. <https://doi.org/10.1108/PAR-03-2016-0030>
- Bogers M, Chesbrough H, Moedas C (2018) Open innovation: research, practices and policies. *Calif Manag Rev* 60(2):5–16. <https://doi.org/10.1177/0008125617745086>
- Bogers M, Chesbrough H, Heaton S, Teece D (2019) Strategic management of open innovation: a dynamic capabilities perspective. *Calif Manag Rev* 62(1):77–94. <https://doi.org/10.1177/0008125619885150>
- Boscherini L, Chiaroni D, Chiesa V, Frattini F (2012) How to integrate open and closed innovation. *Int J Entrep Innov Manag* 16(3/4):226–244. <https://doi.org/10.1504/IJEIM.2012.051957>
- Breusch T, Pagan A (1979) A simple test for heteroscedasticity and random coefficient variation. *Econometrica* 47(5):1287–1294. <https://doi.org/10.2307/1911963>
- Bröring S, Herzog P (2008) Organising new business development: open innovation at Degussa. *Eur J Innov Manag* 11(3):330–348. <https://doi.org/10.1108/14601060810888991>
- Brunswick S, Chesbrough H (2018) The adoption of open innovation in large firms: practices, measures, and risks. *Res Technol Manag* 61(1):35–45. <https://doi.org/10.1080/08956308.2018.1399022>
- Buganza T, Verganti R (2009) Open innovation process to inbound knowledge: collaboration with universities in four leading firms. *Eur J Innov Manag* 12(3):306–325. <https://doi.org/10.1108/14601060910974200>
- Burcharth AL, Knudsen MP, Søndergaard HA (2014) Neither invented nor shared here: the impact and management of attitudes for the adoption of open innovation practices. *Technovation* 34(3):149–161. <https://doi.org/10.1016/j.technovation.2013.11.007>
- Busenbark JR, Graffin SD, Campbell RJ, Lee EY (2022) A marginal effects approach to interpreting main effects and moderation. *Organ Res Methods* 25(1):147–169. <https://doi.org/10.1177/1094428120976838>
- Carmona-Lavado A, Cuevas-Rodríguez G, Cabello-Medina C, Fedriani EM (2021) Does open innovation always work? The role of complementary assets. *Technol Forecast Soc Change* 162:120316. <https://doi.org/10.1016/j.techfore.2020.120316>
- Chan WC, Chen PC, Hung SW, Tsai MC, Chen TK (2017) Open innovation and team leaders' innovation traits. *Eng Manag J* 29(2):87–98. <https://doi.org/10.1080/10429247.2017.1309629>
- Chang Y-C, Chang H-T, Chi H-R, Chen M-H, Deng L-L (2012) How do established firms improve radical innovation performance? The organizational capabilities view. *Technovation* 32(7–8):441–451. <https://doi.org/10.1016/j.technovation.2012.03.001>
- Chesbrough H (2003) The era of open innovation. *MIT Sloan Manag Rev* 44(3):35–41
- Chesbrough H (2024) Open innovation in large companies. In: Chesbrough H, Radziwon A, Vanhaverbeke W, West J (eds) *The Oxford handbook of open innovation*. Oxford University Press, Oxford, pp 158–169. <https://doi.org/10.1093/oxfordhb/9780192899798.013.10>
- Chesbrough H, Brunswick S (2013) Managing open innovation in large firms. Garwood Center for Corporate Innovation at California University, Berkeley in US & Fraunhofer Society in Germany
- Chesbrough H, Crowther A (2006) Beyond high tech: early adopters of open innovation in other industries. *R&D Manag* 36(3):229–236. <https://doi.org/10.1111/j.1467-9310.2006.00428.x>

- Chiaroni D, Chiesa V, Frattini F (2010) Unravelling the process from closed to open innovation: evidence from mature, asset-intensive industries. *R&D Manag* 40(3):222–245. <https://doi.org/10.1111/j.1467-9310.2010.00589.x>
- Chiesa V, Frattini F, Lamberti L, Noci G (2009) Exploring management control in radical innovation projects. *Eur J Innov Manag* 12(4):416–443. <https://doi.org/10.1108/14601060910996909>
- Christensen M, Knudsen T (2010) Design of decision-making organizations. *Manag Sci* 56(1):71–89. <https://doi.org/10.1287/mnsc.1090.1096>
- Claver-Cortés E, Pertusa-Ortega EM, Molina-Azorín JF (2012) Characteristics of organizational structure relating to hybrid competitive strategy: implications for performance. *J Bus Res* 65(7):993–1002. <https://doi.org/10.1016/j.jbusres.2011.04.012>
- Cohen J (1992) Statistical power analysis. *Curr Dir Psychol Sci* 1(3):98–101. <https://doi.org/10.1111/1467-8721.ep10768783>
- Csaszar FA (2012) Organizational structure as a determinant of performance: evidence from mutual funds. *Strateg Manag J* 33(6):611–632. <https://doi.org/10.1002/smj.1969>
- Csaszar FA (2013) An efficient frontier in organization design: organizational structure as a determinant of exploration and exploitation. *Organ Sci* 24(4):1083–1101. <https://doi.org/10.1287/orsc.1120.0784>
- Datta A, Mukherjee D, Jessup L (2015) Understanding commercialization of technological innovation: taking stock and moving forward. *R&D Manag* 45(3):215–249. <https://doi.org/10.1111/radm.12068>
- De Clercq D, Thongpapanl N, Dimov D (2011) A closer look at cross-functional collaboration and product innovativeness: contingency effects of structural and relational context. *J Prod Innov Manag* 28(5):680–697. <https://doi.org/10.1111/j.1540-5885.2011.00830.x>
- DeSanctis G, Glass JT, Ensing IM (2002) Organizational designs for R & D. *Acad Manag Exec* 16(3):55–66. <https://doi.org/10.5465/AME.2002.8540314>
- Dewar RD, Dutton JE (1986) The adoption of radical and incremental innovations: an empirical analysis. *Manag Sci* 32(11):1422–1433. <https://doi.org/10.1287/mnsc.32.11.1422>
- Diamantopoulos A, Sarstedt M, Fuchs C, Wilczynski P, Kaiser S (2012) Guidelines for choosing between multi-item and single-item scales for construct measurement: a predictive validity perspective. *J Acad Mark Sci* 40(3):434–449. <https://doi.org/10.1007/s11747-011-0300-3>
- Du J, Leten B, Vanhaverbeke W (2014) Managing open innovation projects with science-based and market-based partners. *Res Policy* 43(5):828–840. <https://doi.org/10.1016/j.respol.2013.12.008>
- Dzallias M, Blind K (2019) Innovation indicators throughout the innovation process: an extensive literature analysis. *Technovation* 80–81(May 2018):3–29. <https://doi.org/10.1016/j.technovation.2018.05.005>
- Dziurski P (2020) Does industry matter? Drivers and barriers for open innovation in high-tech and non-high-tech industries: evidence from Poland. *Int J Manag Econ* 56(4):307–323. <https://doi.org/10.2478/ijme-2020-0024>
- Egelhoff WG (2020) How a flexible matrix structure could create ambidexterity at the macro level of large, complex organizations like MNCs. *Manag Int Rev* 60(3):459–484. <https://doi.org/10.1007/s11575-020-00418-7>
- El Maalouf N, Bahemia H (2023) The implementation of inbound open innovation at the firm level: a dynamic capability perspective. *Technovation* 122(October 2022):102659. <https://doi.org/10.1016/j.technovation.2022.102659>
- Estrada I, Faems D, Martin Cruz N, Perez Santana P (2016) The role of interpartner dissimilarities in industry-university alliances: insights from a comparative case study. *Res Policy* 45(10):2008–2022. <https://doi.org/10.1016/j.respol.2016.07.005>
- Faems D, De Visser M, Andries P, Van Looy B (2010) Technology alliance portfolios and financial performance: value-enhancing and cost-increasing effects of open innovation. *J Prod Innov Manag* 27(6):785–796. <https://doi.org/10.1111/j.1540-5885.2010.00752.x>
- Felin T, Powell TC (2016) Designing organizations for dynamic capabilities. *Calif Manag Rev* 58(4):78–96. <https://doi.org/10.1525/cmr.2016.58.4.78>
- Felin T, Zenger TR (2014) Closed or open innovation? Problem solving and the governance choice. *Res Policy* 43(5):914–925. <https://doi.org/10.1016/j.respol.2013.09.006>
- Fey CF, Birkinshaw J (2005) External sources of knowledge, governance mode, and R&D performance. *J Manag* 31(4):597–621. <https://doi.org/10.1177/0149206304272346>
- Field A (2018) Discovering statistics using IBM SPSS statistics. In: Seaman J (ed), 5th edn. Sage Publications
- Fornell C, Larcker D (1981) Evaluating structural equation models with unobservable variables and measurement error. *J Mark Res* 18(1):39–50. <https://doi.org/10.2307/3151312>

- Gad David K, Yang W, Pei C, Moosa A (2023) Effect of transformational leadership on open innovation through innovation culture: exploring the moderating role of absorptive capacity. *Technol Anal Strateg Manag* 35(5):613–628. <https://doi.org/10.1080/09537325.2021.1979214>
- Gans JS, Stern S (2010) Is there a market for ideas? *Ind Corp Change* 19(3):805–837. <https://doi.org/10.1093/icc/dtq023>
- Gassmann O, Enkel E (2004) Towards a theory of open innovation: three core process archetypes. In: R&D management conference, 1–18
- Gassmann O, Enkel E, Chesbrough H (2010) The future of open innovation. *R&D Manag* 40(3):213–221. <https://doi.org/10.1111/j.1467-9310.2010.00605.x>
- Gioia DA, Corley KG, Hamilton AL (2013) Seeking qualitative rigor in inductive research: notes on the Gioia methodology. *Organ Res Methods* 16(1):15–31. <https://doi.org/10.1177/1094428112452151>
- Gentile-Lüdecke S, Torres de Oliveira R, Paul J (2020) Does organizational structure facilitate inbound and outbound open innovation in SMEs? *Small Bus Econ* 55(4):1091–1112. <https://doi.org/10.1007/s11187-019-00175-4>
- Grimpe C, Kaiser U (2010) Balancing internal and external knowledge acquisition: the gains and pains from R&D outsourcing. *J Manag Stud* 47(8):1483–1509. <https://doi.org/10.1111/j.1467-6486.2010.00946.x>
- Gruber M, Heinemann F, Brettel M, Hungeling S (2010) Configurations of resources and capabilities and their performance implications: an exploratory study on technology ventures. *Strateg Manag J* 31(12):1337–1356. <https://doi.org/10.1002/smj.865>
- Hayes AF (2013) Introduction to mediation, moderation, and conditional process analysis. Guilford Press, New York
- Hayes AF, Cai L (2007) Using heteroskedasticity-consistent standard error estimators in OLS regression: an introduction and software implementation. *Behav Res Methods* 39:709–722. <https://doi.org/10.3758/BF03192961>
- Helm R, Kloyer M (2004) Controlling contractual exchange risks in R&D interfirm cooperation: an empirical study. *Res Policy* 33(8):1103–1122. <https://doi.org/10.1016/j.respol.2004.05.003>
- Helm R, Mark A (2012) Analysis and evaluation of moderator effects in regression models: state of art, alternatives and empirical example. *RMS* 6(4):307–332. <https://doi.org/10.1007/s11846-010-0057-y>
- Helm R, Endres H, Huesig S (2019) When and how often to externally commercialize technologies? A critical review of outbound open innovation. *RMS* 13:327–345. <https://doi.org/10.1007/s11846-017-0248-x>
- Helm R, Kloyer M, Aust C (2020) R&D collaboration between firms: hard and soft antecedents of supplier knowledge sharing. *Int J Innov Manag* 24(1):2050001-1–2050001-42. <https://doi.org/10.1142/S1363919620500012>
- Hooze S, Béjean M, Arnoux F (2016) Organising for radical innovation: the benefits of the interplay between cognitive and organisational processes in KCP workshops. *Int J Innov Manag* 20(4):1–33. <https://doi.org/10.1142/S1363919616400041>
- Hosseini M, Owlia MS (2016) Designing a model for measuring and analyzing the relational capital using factor analysis: case study, Ansar bank. *J Intellect Cap* 17(4):734–757. <https://doi.org/10.1108/JIC-04-2016-0042>
- Hossain M, Islam KMZ, Sayeed MA, Kauranen I (2016) A comprehensive review of open innovation literature. *J Sci Technol Policy Manag* 7(1):2–25. <https://doi.org/10.1108/JSTPM-02-2015-0009>
- Howell D, Windahl C, Seidel R (2010) A project contingency framework based on uncertainty and its consequences. *Int J Project Manag* 28(3):256–264. <https://doi.org/10.1016/j.ijproman.2009.06.002>
- Huang MH, Chen DZ (2017) How can academic innovation performance in university–industry collaboration be improved? *Technol Forecast Soc Change* 123:210–215. <https://doi.org/10.1016/j.techfore.2016.03.024>
- Huizingh EKRE (2011) Open innovation: state of the art and future perspectives. *Technovation* 31(1):2–9. <https://doi.org/10.1016/j.technovation.2010.10.002>
- Hunt SD, Madhavaram S (2020) Adaptive marketing capabilities, dynamic capabilities, and renewal competences: the “outside vs. inside” and “static vs. dynamic” controversies in strategy. *Ind Mark Manag* 89:129–139. <https://doi.org/10.1016/j.indmarman.2019.07.004>
- Ihl C, Piller FT, Wagner P (2012) Organizing for open innovation: aligning internal structure with external knowledge search. *SSRN Electron J*. <https://doi.org/10.2139/ssrn.2164766>
- Joseph J, Gaba V (2020) Organizational structure, information processing, and decision-making: a retrospective and road map for research. *Acad Manag Ann* 14(1):267–302. <https://doi.org/10.5465/annals.2017.0103>

- Kelley D (2009) Adaptation and organizational connectedness in corporate radical innovation programs. *J Prod Innov Manag* 26(5):487–501. <https://doi.org/10.1111/j.1540-5885.2009.00676.x>
- Kloyer M, Helm R, Aust C (2019) Determinants of moral hazard in research and development supply relations: empirical results beyond the agency-theory explanation. *Manag Decis Econ* 40(1):64–78. <https://doi.org/10.1002/mde.2980>
- Kor YY, Mesko A (2012) Dynamic managerial capabilities: configuration and orchestration of top executives' capabilities and the firm's dominant logic. *Strateg Manag J* 34(2):233–244. <https://doi.org/10.1002/smj.2000>
- Kraft P, Helm R, Dowling M (2021) New business models with Industrie 4.0 in the German Mittelstand. *Int J Technol Policy Manag* 21(1):47–68. <https://doi.org/10.1504/IJTPM.2021.114308>
- Kretschmer T, Puranam P (2008) Integration through incentives within differentiated organizations. *Organ Sci* 19(6):860–875. <https://doi.org/10.1287/orsc.1070.0352>
- Lakemond N, Bengtsson L, Laursen K, Tell F (2016) Match and manage: the use of knowledge matching and project management to integrate knowledge in collaborative inbound open innovation. *Ind Corp Change* 25(2):333–352. <https://doi.org/10.1093/icc/dtw004>
- Lakhani KR, Assaf HL, Tushman ML (2013) Open innovation and organizational boundaries. In: *Handbook of economic organization: integrating economic and organization theory*, Issue Chapter 19, pp 355–382
- Lazzarotti V, Manzini R, Pellegrini L (2011) Firm-specific factors and the openness degree: a survey of Italian firms. *Eur J Innov Manag* 14(4):412–434. <https://doi.org/10.1108/14601061111174899>
- Lee J, Min J, Lee H (2016) The effect of organizational structure on open innovation: a quadratic equation. *Procedia Comput Sci*. <https://doi.org/10.1016/j.procs.2016.07.128>
- Leemann N, Kanbach DK (2022) Toward a taxonomy of dynamic capabilities: a systematic literature review. *Manag Res Rev* 45(4):486–501. <https://doi.org/10.1108/MRR-01-2021-0066>
- Lerch M, Spieth P (2012) Innovation project portfolio management: a meta-analysis. *Int J Prod Dev* 16(1):77–96. <https://doi.org/10.1504/IJPD.2012.047265>
- Li H, Wu Y, Cao D, Wang Y (2021) Organizational mindfulness towards digital transformation as a prerequisite of information processing capability to achieve market agility. *J Bus Res* 122:700–712. <https://doi.org/10.1016/j.jbusres.2019.10.036>
- Lu C, Liu Z, Xu Y, Liao S, Fu L (2022) How TMT diversity influences open innovation: an empirical study on biopharmaceutical firms in China. *Technol Anal Strateg Manag* 34(2):151–165. <https://doi.org/10.1080/09537325.2021.1892056>
- Lyu Y, He B, Zhu Y, Li L (2019) Network embeddedness and inbound open innovation practice: the moderating role of technology cluster. *Technol Forecast Soc Change* 144(2):12–24. <https://doi.org/10.1016/j.techfore.2019.03.018>
- MacKenzie SB, Podsakoff PM (2012) Common method bias in marketing: causes, mechanisms, and procedural remedies. *J Retail* 88(4):542–555. <https://doi.org/10.1016/j.jretai.2012.08.001>
- Manolopoulos D, Söderquist KE, Pearce R (2011) Coordinating decentralized research and development laboratories: a survey analysis. *J Int Manag* 17(2):114–129. <https://doi.org/10.1016/j.intman.2010.09.012>
- Marble RP (2003) A system implementation study: management commitment to project management. *Inf Manag* 41(1):111–123. [https://doi.org/10.1016/S0378-7206\(03\)00031-4](https://doi.org/10.1016/S0378-7206(03)00031-4)
- Markovic S, Bagherzadeh M, Dubiel A, Cheng J, Vanhaverbeke W (2020) Do not miss the boat to outside-in open innovation: enable your employees. *Ind Mark Manag* 91(May):152–161. <https://doi.org/10.1016/j.indmarman.2020.09.003>
- Martin JA (2011) Dynamic managerial capabilities and the multibusiness team: the role of episodic teams in executive leadership groups. *Organ Sci* 22(1):118–140. <https://doi.org/10.1287/orsc.1090.0515>
- McDermott CM, O'Connor GC (2002) Managing radical innovation: an overview of emergent strategy issues. *J Product Innov Manag* 19(6):424–438. <https://doi.org/10.1111/1540-5885.1960424>
- Miles R, Snow C, Miles G, Blomqvist K, Rocha H (2009) The I-Form organization. *Calif Manag Rev* 51(4):61–76. <https://doi.org/10.2307/41166505>
- Mokhtarzadeh NG, Mahdiraji HA, Jafarpanah I, Cao D (2022) Examining the influence of environmental turbulence on firm innovation performance in emerging markets: using an environment-strategy-performance framework. *Int J Innov Manag* 26(4):1–29. <https://doi.org/10.1142/S1363919622500281>
- Musioli J, Markard J, Hekkert M, Furrer B (2020) Creating innovation systems: How resource constellations affect the strategies of system builders. *Technol Forecast Soc Change* 153:119209. <https://doi.org/10.1016/j.techfore.2018.02.002>

- Naqshbandi MM, Jasimuddin SM (2018) Knowledge-oriented leadership and open innovation: role of knowledge management capability in France-based multinationals. *Int Bus Rev* 27(3):701–713. <https://doi.org/10.1016/j.ibusrev.2017.12.001>
- Naqshbandi MM, Tabche I, Choudhary N (2019) Managing open innovation: the roles of empowering leadership and employee involvement climate. *Manag Decis* 57(3):703–723. <https://doi.org/10.1108/MD-07-2017-0660>
- Nieto M, Mateo JP (2020) Dynamic efficiency in a planned economy: innovation and entrepreneurship without markets. *Sci Soc* 84(1):42–66. <https://doi.org/10.1521/siso.2020.84.1.42>
- O'Connor GC, DeMartino R (2006) Organizing for radical innovation: an exploratory study of the structural aspects of RI management systems in large established firms. *J Prod Innov Manag* 23(6):475–497. <https://doi.org/10.1111/j.1540-5885.2006.00219.x>
- Pellizzoni E, Trabucchi D, Buganza T (2019) When agility meets open innovation: two approaches to manage inbound projects. *Creat Innov Manag* 28(4):464–476. <https://doi.org/10.1111/caim.12337>
- Pertusa-Ortega EM, Zaragoza-Sáez P, Claver-Cortés E (2010) Can formalization, complexity, and centralization influence knowledge performance? *J Bus Res* 63(3):310–320. <https://doi.org/10.1016/j.jbusres.2009.03.015>
- Pilav-Velic A, Jahic H (2021) The adoption of inbound open innovation practices in developing countries: empirical evidence from the manufacturing sector. *Eur J Innov Manag* 25(3):774–790. <https://doi.org/10.1108/EJIM-11-2020-0460>
- Poehlmann K, Helm R, Mauroner O, Auburger J (2021) Corporate spin-offs' success factors: management lessons from a comparative empirical analysis with research-based spin-offs. *RMS* 15(6):1767–1796. <https://doi.org/10.1007/s11846-020-00402-3>
- Prein G, Kluge S, Kelle U (1994) Strategien zur Sicherung der Repräsentativität und Stichprobenvalidität bei kleinen Samples
- Rammer C (2011) Bedeutung von Spitzentechnologien, FuE-Intensität und nicht forschungsintensiven Industrien für Innovationen und Innovationsförderung in Deutschland. 11(01). ZEW-Dokumentation
- Rammer C, Doherr T, Krieger B, Niggemann H, Peters B, Schubert T, Trunschke M, von der Burg J, Eibelschäuser S (2024) Innovationen in der deutschen Wirtschaft: Indikatorenbericht zur Innovationserhebung 2023. ZEW - Leibniz Centre for European Economic Research. <https://hdl.handle.net/10419/300549>
- Rampersad GC, Hordacre AL, Spoehr J (2020) Driving innovation in supply chains: an examination of advanced manufacturing and food industries. *J Bus Ind Mark* 35(5):835–847. <https://doi.org/10.1108/JBIM-03-2019-0101>
- Reitzig M, Maciejovsky B (2015) Corporate hierarchy and vertical information flow inside the firm: a behavioral view. *Strateg Manag J* 36(13):1979–1999. <https://doi.org/10.1002/smj.2334>
- Rönnberg D, Eriksson PE, Frishammar J (2011) Open innovation in process industries: a lifecycle perspective on development of process equipment. *Int J Technol Manag* 56(October):225–239. <https://doi.org/10.1504/IJTM.2011.042984>
- Roszkowska D (2017) External knowledge sourcing and innovation processes in modern economic environment. *Int J Manag Econ* 53(2):39–56. <https://doi.org/10.1515/ijme-2017-0011>
- Saeed S, Yousafzai S, Paladino A, De Luca LM (2015) Inside-out and outside-in orientations: a meta-analysis of orientation's effects on innovation and firm performance. *Ind Mark Manage* 47:121–133. <https://doi.org/10.1016/j.indmarman.2015.02.037>
- Sandberg B, Aarikka-Stenroos L (2014) What makes it so difficult? A systematic review on barriers to radical innovation. *Ind Mark Manage* 43(8):1293–1305. <https://doi.org/10.1016/j.indmarman.2014.08.003>
- Schaller TK, Patil A, Malhotra NK (2015) Alternative techniques for assessing common method variance: an analysis of the theory of planned behavior research. *Organ Res Methods* 18(2):177–206. <https://doi.org/10.1177/1094428114554398>
- Schilke O, Hu S, Helfat CE (2018) Quo vadis, dynamic capabilities? A content-analytic review of the current state of knowledge and recommendations for future research. *Acad Manag Ann* 12(1):390–439. <https://doi.org/10.5465/annals.2016.0014>
- Schmidt S, von der Oelsnitz D (2020) Innovative business development: identifying and supporting future radical innovators. *Leadersh Educ Personal Interdiscip J* 2(1):9–21. <https://doi.org/10.1365/s42681-020-00008-z>
- Seo R, Park J-H (2022) When is interorganizational learning beneficial for inbound open innovation of ventures? A contingent role of entrepreneurial orientation. *Technovation* 116:102514. <https://doi.org/10.1016/j.technovation.2022.102514>

- Siemsen E, Roth A, Oliveira P (2010) Common method bias in regression models with linear, quadratic, and interaction effects. *Organ Res Methods* 13(3):456–476. <https://doi.org/10.1177/1094428109351241>
- Soellner S, Helm R, Klee P, Endres H (2024) Industrial service innovation: exploring the transformation process to digital servitization in industrial goods companies. *Ind Mark Manag* 117:288–303. <https://doi.org/10.1016/j.indmarman.2024.01.009>
- Siggelkow N, Rivkin JW (2005) Speed and search: designing organizations for turbulence and complexity. *Organ Sci* 16(2):101–122. <https://doi.org/10.1287/orsc.1050.0116>
- Stea D, Foss K, Foss NJ (2015) A neglected role for organizational design: supporting the credibility of delegation in organizations. *J Organ des* 4(3):3–17. <https://doi.org/10.7146/jod.20434>
- Tang TY, Fisher GJ, Qualls WJ (2021) The effects of inbound open innovation, outbound open innovation, and team role diversity on open source software project performance. *Ind Mark Manag* 94:216–228. <https://doi.org/10.1016/j.indmarman.2021.02.013>
- Teece D (2016a) Dynamic capabilities and strategic management. *Palgrave Encycl Strateg Manag* 18(April 1991):1–9. https://doi.org/10.1057/978-1-349-94848-2_689-1
- Teece D (2016b) Dynamic capabilities and entrepreneurial management in large organizations: toward a theory of the (entrepreneurial) firm. *Eur Econ Rev* 86:202–216. <https://doi.org/10.1016/j.euroecorev.2015.11.006>
- Tiberius V, Schwarzer H, Roig-Dobón S (2021) Radical innovations: between established knowledge and future research opportunities. *J Innov Knowl* 6(3):145–153. <https://doi.org/10.1016/j.jik.2020.09.001>
- Tohidi H, Mohsen Seyedaliakbar S, Mandegari M (2012) Organizational learning measurement and the effect on firm innovation. *J Enterp Inf Manag* 25(3):219–245. <https://doi.org/10.1108/17410391211224390>
- Tranfield D, Denyer D, Smart P (2003) Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *Br J Manag* 14(3):207–222. <https://doi.org/10.1111/1467-8551.00375>
- Turulja L, Bajgoric N (2019) Innovation, firms' performance and environmental turbulence: is there a moderator or mediator? *Eur J Innov Manag* 22(1):213–232. <https://doi.org/10.1108/EJIM-03-2018-0064>
- Urbinati A, Landoni P, Cococcioni F, De Giudici L (2021) Stakeholder management in open innovation projects: a multiple case study analysis. *Eur J Innov Manag* 24(5):1595–1624. <https://doi.org/10.1108/EJIM-03-2020-0076>
- Vahter P, Love JH, Roper S (2014) Openness and innovation performance: are small firms different? *Ind Innov* 21(7–8):553–573. <https://doi.org/10.1080/13662716.2015.1012825>
- Veile JW, Schmidt MC, Voigt KI (2022) Toward a new era of cooperation: how industrial digital platforms transform business models in Industry 4.0. *J Bus Res* 143:387–405. <https://doi.org/10.1016/j.jbusres.2021.11.062>
- vom Brocke J, Lippe S (2015) Managing collaborative research projects: a synthesis of project management literature and directives for future research. *Int J Project Manag* 33(5):1022–1039. <https://doi.org/10.1016/j.ijproman.2015.02.001>
- West J, Bogers M (2014) Leveraging external sources of innovation: a review of research on open innovation. *J Prod Innov Manag* 31(4):814–831. <https://doi.org/10.1111/jpim.12125>
- West J, Bogers M (2017) Open innovation: current status and research opportunities. *Organ Manag* 19(1):43–50. <https://doi.org/10.1080/14479338.2016.1258995>
- Wijethilake C, Lama T (2019) Sustainability core values and sustainability risk management: moderating effects of top management commitment and stakeholder pressure. *Bus Strateg Environ* 28(1):143–154. <https://doi.org/10.1002/bse.2245>
- Wilden R, Gudergan SP, Nielsen BB, Lings I (2013) Dynamic capabilities and performance: strategy, structure and environment. *Long Range Plan* 46(1–2):72–96. <https://doi.org/10.1016/j.lrp.2012.12.001>
- Will MG, Al-Kfairy M, Mellor RB (2019) How organizational structure transforms risky innovations into performance: a computer simulation. *Simul Model Pract Theory* 94(January):264–285. <https://doi.org/10.1016/j.simpat.2019.03.007>
- Yun JH, Won DK, Park K (2016) Dynamics from open innovation to evolutionary change. *J Open Innov Technol Mark Complex* 2(2):1–22. <https://doi.org/10.1186/s40852-016-0033-0>