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The role of open innovation hubs and perceived collective efficacy on individual behaviour in open innovation projects^{*}

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Abstract

The effectiveness of a company's open innovation (OI) strategy strongly depends on the performance of the innovation projects it launches. However, OI research has dedicated only scant attention to the role played by the behavior of individuals involved in these projects. This study focuses on the role played by an open innovation hub (OIH), an in-house unit supporting and accelerating OI initiatives, and investigates how OIHs influence the innovative behavior of employees involved in innovation projects. In particular, this study employs social cognitive theory as a theoretical lens and investigates the role of project members' collective efficacy. Specifically, we developed two hypotheses that were tested using empirical analysis, with survey data from 134 individuals involved in OI projects and operating in 16 Japanese companies. Our study contributes to the literature by illuminating how the perceived collective efficacy of the employees involved in an innovation project influences their behaviors. We find that the support offered by an OIH strengthens the project members' perceived collective efficacy, and, in turn, supports their innovative behavior.

Keywords

open innovation; open innovation projects; collective efficacy; open innovation hub; innovative behavior; creativity; exploration; inclusive leadership; structural equation modeling

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1. Introduction

The effectiveness of a company's open innovation (OI) strategy strongly depends on the performance of the innovation projects launched and driven by employees (Bogers et al., 2017; Brunswicker & Chesbrough, 2018). Companies have to redesign internal and boundary-spanning processes and activities to open up innovation processes and reap the full benefits of OI (Bianchi et al., 2016; Chiaroni et al., 2011). The required organizational redesign can result in high innovation performance only when employees' behavior becomes more creative and innovative in each project (Keinz et al., 2021).

Despite this, only recently have scholars started paying attention to the project level dynamics and mechanisms underlying OI (Barbosa et al., 2021; Du et al., 2014; Gomes et al., 2021). By adopting the project level as the unit of analysis, scholars investigated which organizational solutions positively impact the performance of OI projects and why (Barbosa et al., 2021; Grönlund et al., 2010). Other scholars have focused on the behavior of individual employees involved in OI projects and investigate which mechanisms underlie this behavior. Another stream of research adopting this perspective is grounded in the human resource management and organizational behavior literature, which mainly concerns the psychological and behavioral aspects of the management of innovation projects (Ardito et al., 2017; Lewin et al., 2011; Locatelli et al., 2020; Natalicchio et al., 2018). These studies shape one of the streams of OI research at the project level, that is, investigating the behavior of individual employees involved in OI projects to examine the relationship between organizational solutions and OI project performances (Bogers et al., 2017; Keinz et al., 2021).

This study positions itself in the streams of research highlighted previously, since the aim is to identify the most important mechanisms explaining how a certain organizational solution affects the behavior of individuals involved in OI projects. In particular, this study focuses on the presence and role played by an open innovation hub (OIH), which is an in-house unit dedicated to supporting and accelerating the company's OI initiatives (Miller et al., 2014; O'Connor & DeMartino, 2006).

Many scholars and practitioners have found that a company can nurture and streamline its OI processes by establishing an OIH (Bianchi et al., 2016; Kiran & Sharma, 2021; Kirschbaum, 2005; Kodama & Shibata, 2016; Lichtenthaler, 2008; Miller et al., 2014; Richter et al., 2018; Wikhamn & Styhre, 2019). Accordingly, companies have increasingly adopted this organizational solution in recent years. For instance, Fujifilm established an OIH in 2014 to promote and strengthen collaborations between external individuals and Fujifilm's employees, hence promoting a collaborative environment in the whole company (Kodama & Shibata, 2016). Similarly, Cisco established an OIH to connect its employees with potential partners for scouting technologies in new knowledge and market domains (Miller et al., 2014). The OIH provides various services to employees involved in OI projects, including consulting and other support services (Miller et al., 2014). In particular, an OIH may work as a change agent, solving conflicts that often arise when introducing OI in large companies (Wikhamn, 2019). Therefore, OIHs appear as effective organizational solutions to improve the performance of OI projects by

nurturing employees' innovativeness (Kodama & Shibata, 2016; Lichtenthaler, 2008; Miller et al., 2014; Richter et al., 2018). However, despite the many recent calls for deepening this level of analysis in OI research (Bogers et al., 2017; Randhawa et al., 2016), existing research lacks an understanding of the project and individual level mechanisms that explain the impact OIHs have on OI projects.

The aim of this study is to theoretically and empirically examine how an OIH promotes OI, by focusing on the behavior of individuals involved in the OI project. That is, we theorize and empirically study the role of OIHs as organizational solutions that support the adoption of OI by focusing on their impact on employees' beliefs and innovative behavior in OI projects (see, e.g., Ardito et al., 2017; Lewin et al., 2011; Locatelli et al., 2020; Natalicchio et al., 2018, for related research). In particular, we investigate the relationship between the operations of OIHs and employees' innovative behavior in OI projects by employing collective efficacy as a theoretical lens. Collective efficacy is defined as "a group's shared belief in its conjoint capabilities to organize and execute the courses of action required to produce given levels of attainments" (Bandura, 1997, p. 477). When employees perform creative and innovative works, they often have sufficient belief in their capability of creativities and innovativeness (Gibson & Earley, 2007; Kim & Shin, 2015; Yaakobi & Weisberg, 2018) and we assume that the collective efficacy of project members will be a key driver of their OI activities.

Therefore, we focus on the influence and role played by the behavior of individuals involved in OI projects as the unit of analysis, by investigating (i) the interplay between perceived collective efficacy and the innovative behavior of employees involved in OI projects, reflected by employees' capability of exploring new knowledge and recombining it in a creative manner, and (ii) the influence of OIH operations on collective efficacy. By adopting this perspective, we test two hypotheses with data collected through a survey on a sample of 134 employees engaged in OI projects and operating in 16 Japanese companies from a variety of industries. The major contribution of this study is to identify the significant role of collective efficacy in OI project management and, hence, unveil novel theoretical mechanisms explaining how the establishment of an OIH fosters individuals' innovative behavior in an OI project.

The remainder of this paper is structured as follows. The next section provides the theoretical framework and develops the hypotheses. Then, we explain the research method. Finally, we present the results of the survey, test our hypotheses, and discuss the main implications of our study, as well as its limitations and the potential directions for future research.

2. Theoretical background and research hypotheses

2.1. Project level employees' behavior underpinning OI performance

The recent emergence of OIHs has attracted scholars' attention because this organizational solution potentially plays a crucial role in fostering OI by triggering and nurturing employees' innovative behavior at the project level (Bianchi et al., 2016; Miller et al., 2014; O'Connor & DeMartino, 2006). An OIH is an in-house unit dedicated to supporting and accelerating the company's OI initiatives by helping employees develop OI projects through the

provision of various types of services to project members and by championing OI projects in the organization (Kiran and Sharma, 2021; Miller et al., 2014; O'Connor & DeMartino, 2006). For example, as a broker, the OIH connects members of OI projects with potential partners who have the knowledge and expertise to tackle complex innovation problems and, as a consultant, the hub provides the required expertise to conduct the project successfully (Kirschbaum, 2005; Kodama & Shibata, 2016; Miller et al., 2014). Moreover, an OIH, as a champion, protects OI projects from status-quo biases, and encourages as well as motivates project members to pursue the goals of OI projects (Chesbrough & Crowther, 2006; Miller et al., 2014; O'Connor & DeMartino, 2006; Wikhamn, 2019).

To capture employees' innovative behavior as an outcome of OIHs' support, this study focuses on employees' knowledge exploration and creativity (Ardito et al., 2017; Brunswicker & Chesbrough, 2018; Du et al., 2014; Lewin et al., 2011; Locatelli et al., 2020). Both these variables have been proven to affect employees' innovativeness, thus sustaining their capability to develop OI projects (Lichtenthaler & Lichtenthaler, 2009). On one hand, knowledge exploration is defined as the creation of variety in experience that is associated with broadening employees' existing knowledge base (Mom et al., 2007). In an OI project, the members have to start by searching and acquiring knowledge from both inside and outside the company (Lichtenthaler & Lichtenthaler, 2009). Employees' creativity, on the other hand, refers to a behavior characterized by "production of novel and useful ideas" (Amabile, 1988, p. 126). As OI also requires the exploitation of acquired knowledge (Lichtenthaler & Lichtenthaler, 2009), the production of novel and useful ideas by leveraging acquired knowledge is also crucial to successfully implement OI projects. Therefore, knowledge exploration and creativity of employees represent the fundamental building blocks of successful OI strategies (Kirschbaum, 2005; Lichtenthaler, 2008; Lichtenthaler & Lichtenthaler, 2009) and, accordingly, we focus on these core variables to capture behavioral outcomes in OI projects.

2.2. Collective efficacy as a key determinant of employees' innovative behavior

In our model, the innovation behavior of project members depends on the OIH's mode of operation, which is likely to vary across projects. According to the social cognitive theory, the OIH works as external environment that influences individuals' cognitive factors and behaviors (Bandura, 1997; Gibson & Earley, 2007; Wood & Bandura, 1989). Given this call for shedding new light on individuals' cognitive factors as antecedents of behavior, the present study considers collective efficacy. Collective efficacy is "a group's shared belief in its conjoint capabilities to organize and execute the courses of action required to produce given levels of attainments" (Bandura, 1997, p. 477). We assume that OIHs may influence employees' collective efficacy, which, in turn, may influence their innovative behavior during their OI projects (Gibson & Earley, 2007). In particular, perception of collective efficacy may differ among members of the same organization based on their circumstances; hence, each member's behavior depends on how they perceive collective efficacy of the organization (Bandura, 1997; Cady et al., 2018; Goddard et al., 2004). In the following, we focus on perceived collective efficacy, which reflects how each employee perceives the collective efficacy of his/her organization.

There are several reasons why we focus on perceived collective efficacy. First, perceived collective efficacy strongly influences the behavior of group members (Bandura, 1997; Gibson & Earley, 2007; Goddard, Hoy, & Hoy, 2004). Collective efficacy determines the group performance, since members' positive belief or confidence in the group's capabilities produces an organizational climate that motivates the members to use their capabilities to pursue the group's overall goal (Goddard et al., 2004). Thus, when organizational members perceive stronger collective efficacy in specific tasks, they engage in behavior to pursue those tasks (Gibson & Earley, 2007). That is, each individual's beliefs regarding the capabilities of the organization as a whole influences their behavior.

Second, given these general effects of perceived collective efficacy on people's behavior, we can more specifically assume that the employees' perceived collective efficacy in innovation fosters their knowledge exploration and creativity. Both knowledge exploration and creative behavior are characterized by unpredictability of results. Hence, employees often consider these behaviors risky (Dewett, 2006; March, 1991). However, a positive belief in the innovative capabilities of the organization as a whole may reduce this uncertainty because the organization-wide belief in the innovation capabilities produces a climate that encourages organizational members to engage in innovative actions, despite the risk (Bandura, 1997; Goddard et al., 2004). In this light, we can assume that perceived collective efficacy in innovation encourages employees to take risks to pursue knowledge exploration and creativity. Several studies support this assumption (Kim & Shin, 2015; Yaakobi & Weisberg, 2018). Therefore, we assume that when employees have a stronger perception of collective efficacy in innovation, (i.e. when employees develop a stronger belief in the innovation capabilities of the organization), they are more likely to explore new knowledge and use the obtained knowledge creatively. Formally:

- H1a. Employees' perceived collective efficacy positively influences their exploration of new knowledge in OI projects.
- H1b. Employees' perceived collective efficacy positively influences their creativity in OI projects.

2.3. OIHs' influence on collective efficacy of employees

To shed more light on this topic, we also investigate a linkage between the support provided by an OIH, which varies across projects, and the collective efficacy that the project members perceive. Hence, we focus on several sources of collective efficacy belief. The social cognitive theory has identified four major factors related to perceived collective efficacy of organizational members—direct experience, vicarious experience, social persuasion, and affective status (Bandura, 1997; Gibson & Earley, 2007; Goddard et al., 2004). Both direct and vicarious experience of the relationship between capability use and resulting performance convince people of their own capabilities (Goddard et al., 2004). Social persuasion, namely, performance feedback from supervisors or colleagues, also affects perceived collective efficacy of organizational members (Prussia & Kinicki, 1996). Finally, groups' affective status may influence how people interpret and react to environmental stress. For example, encouraged,

proactive, or hopeful people tend to believe that they are capable of solving problems (Goddard et al., 2004).

These theories suggest that an OIH may enhance employees' perceived collective efficacy for two main reasons. First, in terms of direct and vicarious experience, we focus on various types of services that OIHs typically provide to the members of OI projects, for example, brokering or consulting. Qualitative studies on OIHs have revealed that these hubs work as knowledge brokers and facilitate knowledge flows from both inside and outside the company (Kodama & Shibata, 2016), hence offering opportunities to open up the innovation process. These practical services provide opportunities that the project members actually benefit from through direct experiences of OI activities. Another study also argues that an OIH works as an "internal consultant" that provides employees with the expertise to conduct OI projects successfully (Kirschbaum, 2005). These knowledge-providing services give the project members vicarious experiences of successful OI practices. Given these two mechanisms, the OIH can foster project members' perceived collective efficacy (Goddard et al., 2015). Therefore, we assume that when project members use various types of services provided by the OIH, they gain various direct and vicarious experiences and foster their perceived collective efficacy.

H2a: The variety of services offered by the OIH to employees involved in OI projects positively influences their perceived collective efficacy.

Second, in terms of the social persuasion and the affective state, we focus on OIHs' inclusiveness of project members. For instance, an OIH can also provide positive feedback to members of OI projects and encourage them to believe in their OI capability. As OI initiatives include changes in thoughts and behavior (Chiaroni et al., 2011), members of OI projects face several difficulties, such as the not-invented-here syndrome (Chesbrough & Crowther, 2006). These negative experiences may discourage the project members and weaken their belief in organizational capabilities (Prussia & Kinicki, 1996). To address these problems, the members of OIHs may work as champions or mentors and give positive feedback and encouragement to project members, hence nurturing their collective efficacy in innovation (Chesbrough & Crowther, 2006). In other words, the positive feedback from an OIH to project members works as social persuasion and influences the affective state, which, in turn, fosters perceived collective efficacy (Bandura, 1997; Gibson & Earley, 2007; Goddard et al., 2004).

This function of OIHs, persuading and encouraging employees to believe in their collective capabilities, is also supported by the leadership literature. Recently, scholars have drawn attention to inclusive leadership, which is defined "as words and deeds by a leader or leaders that indicate an invitation and appreciation for others' contributions" (Nembhard & Edmondson, 2006, p. 947), and revealed its positive impact on followers' innovative behavior (e.g., Carmeli et al., 2010). When leaders show inclusiveness, that is, they communicate openly, and are always available and accessible, their followers feel safe and encouraged, and are thus more confident about facing difficult and complex tasks (Carmeli et al., 2010; Nembhard & Edmondson, 2006). Therefore, it may be assumed that when the OIH promotes inclusiveness,

more specifically, when the members of the OIH exhibit inclusive leadership when collaborating with employees involved in OI projects, project members tend to receive positive feedback about their OI initiatives, are more motivated to use their capabilities (Nembhard & Edmondson, 2006), and perceive stronger collective efficacy. On the contrary, if the OIH is forcible or bureaucratic, project members may become indifferent and discouraged. Accordingly, we hypothesize that:

H2b: Inclusive leadership exhibited by the OIH during interactions with the employees involved in OI projects positively influences employees' perceived collective efficacy.

3. Method

3.1. Sample and procedure

The present study surveyed 134 employees who engaged in OI projects and operated in 16 different Japanese companies. We selected this setting for a number of reasons. First, to analyze employees' behaviors and their antecedents, we required data from individuals who directly engaged in OI projects. Second, we selected Japanese companies because empirical studies of OI by Japanese companies are limited except for case-based research (Kodama & Shibata, 2016) or one industry-specific survey (Ishikawa & Suzuki, 2018). Hence, this allows us to expand the geographical coverage of empirical studies in OI. Finally, we selected Japanese companies for accessibility. One of the co-authors had already established strong and stable relationships with a number of Japanese firms operating in various industries, thus obtaining the opportunity to interact with managers and employees for conducting the survey and access data and information.

We collected this sample using the non-probability method, specifically through network sampling (Vehovar et al., 2016). We contacted companies that one of the co-authors had already established a relationship with. Here, we applied two criteria: having an OIH and actively conducting OI projects. Our company selection was also based on maximizing industrial diversity. Finally, we obtained a sample composed of 16 different companies (see Table 1). Thereafter, we asked each contact person (i.e., a member of each company's OIH) to select survey participants from the company. For the selection, we used two criteria: i) participants should have recently engaged in an OI project and ii) they should have had the opportunity to perform creative work on that project. These criteria allowed us to select those employees who had significantly contributed to the project's development. The contact persons prompted participants to respond to an online survey. In total, 134 employees responded to the online survey. The number of respondents per company ranged from 1 to 23, with a mean of 8.3 (Table 1). We considered that all the responses pertained to different projects¹. The respondents' average age was 46.6 and the average tenure of employment was 20.0 years. About 16% of the participants were female. Around 30%, 41%, and 29% of the participants were general managers, section managers, and general employees, respectively.

Table 1 Industry and number of respondents from participating companies

Company	Industry	Number of respondents
1	Food	6
2	Printing and allied industry	6
3	Construction	1
4	Printing and allied industry	5
5	Chemical and allied products	11
6	Electrical machinery, equipment and supplies	13
7	Production machinery	3
8	Electrical machinery, equipment and supplies	23
9	Chemical and allied products	15
10	Information services	8
11	Communications	12
12	Production and distribution of gas	10
13	Information services	3
14	Drugs and medicines	12
15	Drugs and medicines	5
16	Manufacture of textile mill products	1
Total		134

3.2. Measures

All measurement items are shown in Appendix A. We instructed participants to recall an OI project that they had developed recently and evaluate their activities and the relevant OIH's operation during that project. This instruction assured that 1) the participants were focused on one recent project, even if they had engaged in multiple projects, and 2) the participants considered the OIH's operation in terms of the project level attributes for each project. Furthermore, we minimized retrospective bias by framing questions in the context of the recent project (Mathur et al., 2013).

Knowledge exploration. We used four items related to employees' knowledge exploration developed and used by Mom et al. (2007). Respondents were asked to indicate the frequency of their explorative behavior during the focal OI project. Responses were provided on a six-point scale ranging from 1 (*not at all*) to 6 (*almost always*).

Creativity. This measure assessed how an employee used acquired knowledge in a creative manner during the development of an OI project (Amabile, 1988; Carmeli et al., 2010; Tierney et al., 1999). We used a four-item measure developed and used by Tierney et al. (1999). Respondents were asked to express the extent to which they exhibited various behaviors, which indicated the level of creativity in the focal OI project. Responses were recorded on a five-point

scale ranging from 1 (*not at all*) to 5 (*to a great extent*).

Perceived collective efficacy. Perceived collective efficacy was measured as the employees' evaluation of their company's capability of capturing benefits from OI (Bandura, 1997; Goddard et al., 2004). We developed an original five-item measure relevant to an OI initiative by examining the literature on collective efficacy (Bandura, 1997; Gibson & Earley, 2007; Goddard et al., 2004) and OI (Chesbrough, 2003; Chiaroni et al., 2011; Lichtenthaler & Lichtenthaler, 2009). Respondents were asked to indicate their beliefs about the company's ability to develop new business or innovation through OI. Responses were made on a six-point scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Factor analyses produced a one-factor solution with an eigenvalue of 3.84, explaining 76.7% of the variance. Factor loadings ranged from .83 to .92. Thus, this measure revealed high internal consistency; finally, the Cronbach's alpha was .92. In addition, we used one-way analysis of variance (ANOVA) to test whether the perceived collective efficacy was consistent for all respondents within each company. The one-way ANOVA ($F=0.66$, $p=0.82$) revealed that the perceived collective efficacy varied across individuals within each company. This result is consistent with previous literature, revealing that perceived collective efficacy is not a monolithic group attribute and varies within a group (Bandura, 1997; Cady et al., 2018; Goddard et al., 2004). Thus, this measure captures each individual's evaluation of the company's OI capabilities as a whole.

Variety of OIH's services. This measure assessed the extent to which an OIH provided various services for the employees developing an OI project. It captured the project level operation of the OIH that potentially varied across projects. Respondents were asked to indicate the type(s) of OIH services that they used in their OI project from a list consisting of: *matching events, information service about potential partners, education, mentoring, capital investment as corporate venture capital, acceleration, support for product or service development, support for marketing activities, support for licensing, internal coordination, support for securing a budget, and others*. We developed this list based on the literature on OIHs' operation (Bianchi et al., 2016; Kirschbaum, 2005; Kodama & Shibata, 2016; Lichtenthaler, 2008; Miller et al., 2014; Richter et al., 2018; Wikhamn & Styhre, 2019). We summed up the number of supports used by each employee as this measure, which reflected each employee's experience during their project. The number ranged from 0 to 10, with a mean of 1.94.

OIH's inclusive leadership. This measure captured each project member's perception of the OIH's leadership in their project, and thus potentially varied across projects. We employed the five inclusive-leadership items developed by Carmeli et al. (2010) and asked employees to assess the OIH's inclusiveness on a five-point scale (ranging from 1 = *not at all*, to 5 = *to a great extent*), describing the extent to which their OIH displayed an openness and was available and accessible for them during their OI projects. This measure captured each employee's evaluation of the OIH's inclusive leadership during the project. Similar to Carmeli et al. (2010), the results of factor analyses produced a one-factor solution with an eigenvalue of 3.58, which explained

71.2% of the variance.

Control variables. We controlled for the development stage of the project because this variable could influence the other variables. We asked participants to categorize their projects into six project types: 1 = exploring ideas for a new product or business, 2 = exploring potential customers of a new product or business, 3 = searching for a research and development (R&D) collaborator to develop a new product or service, 4 = searching for partners to sell a new product or service, 5 = exploring partners for introducing information technology systems, and 6 = others. No respondent selected option 5. The responses for option 6 were reallocated into other categories according to their descriptions. Then, we reconstructed these responses into a three-level ordinal scale reflecting the progress of project development: 1 = idea exploration (1), 2 = development (3), and 3 = commercialization (2, 4). The proportions of each project type were 51.5% for explorative, 38.1% for development, and 10.4% for commercialization.

Common method variance (CMV) bias. To reduce the CMV bias from the cross-sectional self-report survey, we followed the recommendation of Podsakoff et al. (2003). First, we ensured respondent anonymity and confidentiality during data collection to reduce respondents' likelihood of editing their responses to be, for example, socially desirable. Second, we designed an online survey to ensure a psychological separation between the measures of independent and dependent variables. That is, we inserted a page break and a break question ("Which is your favorite beverage to drink for a break?") between those measures. Third, after data collection, we tested the CMV bias using the single-common-method-factor approach. We estimated two confirmatory factor analyses (CFA), (a) one that excluded and (b) the other that included a latent method factor on which all items were loaded. We compared both in terms of the structural parameters (correlations) between each item and our measurement variables; we observed no significant difference in correlations between each pair of items and variables (the largest difference was less than 0.001). Therefore, we concluded that the risk of CMV bias was minimal.

3.3. Data analysis

We used structural equation modeling (SEM) to test our hypotheses. Specifically, we employed a two-step approach to SEM, in which construct validity was assessed using CFA, followed by an analysis of structural model (Anderson & Gerbing, 1988). We assessed the model fit on our data based on several goodness-of-fit indexes (Schermelleh-Engel et al., 2003), including the chi-square statistic divided by the degrees of freedom (χ^2/df), the root mean square error of approximation (RMSEA), the Tucker–Lewis coefficient (TLI), the comparative fit index (CFI), and the standardized root mean squared residual (SRMR). We estimated the parameters using the software Stata 14.2 (StataCorp LLC).

4. Results

4.1. Measurement model

Table 2 presents the means, standard deviations, and correlations of the variables used in this study. The correlation matrix indicates that the variety of services and the inclusive leadership of the OIH were positively associated with perceived collective efficacy ($\rho = .20, p < .05$, and $\rho = .31, p < .05$, respectively). Our results also indicate that perceived collective efficacy was positively associated with knowledge exploration ($\rho = .35, p < .05$) and creativity ($\rho = .25, p < .05$). In addition, as we collected data from 16 companies, we calculated intraclass correlation (ICC) to test the consistency of each value within companies (LeBreton & Senter, 2008). Results revealed that ICC(1) ranged from $-.04$ to $.08$ and ICC(2) ranged from $-.56$ to $.43$. These values were lower than the cutoff that recommended aggregation; hence, we did not employ a multi-level model (LeBreton & Senter, 2008; Tan et al., 2021).

Table 2. Means, standard deviation, and correlations of the variables

Variables	Mean	S.D.	1	2	3	4	5
1. Project type							
2. Variety of OIH's services	1.93	1.89	.32*				
3. OIH's inclusive leadership	3.92	0.79	.03	.25*			
4. Perceived collective efficacy	4.37	0.92	-.07	.20*	.31*		
5. Knowledge exploration	4.04	0.93	.03	.20*	.15	.35*	
6. Creativity	3.30	0.80	-.07	.08	.19*	.25*	.44*

Note: $n=134$. Spearman's rank correlation coefficient. * $p < .05$, two-tailed test.

We used CFA to justify and confirm our measurement model (Anderson & Gerbing, 1988), which consists of four latent variables: i) the OIH's inclusive leadership, ii) perceived collective efficacy, iii) knowledge exploration, and iv) creativity. The measurement model showed an acceptable fit to the data: $\chi^2/df = 1.7$, RMSEA = .07, CFI = .94, TLI = .92, and SRMR = .06. The factor loading of all items ranged from .54 to .92. Then, we calculated composite reliability (CR) and average variance extracted (AVE) from the results of the CFA (Table 3). The CR and AVE of all latent variables were above the required threshold (0.6 for CR and 0.5 for AVE), and the convergent validity of our measurement model was confirmed (Bagozzi & Yi, 1988; Fornell & Larcker, 1981). Moreover, the square root of AVE for each latent variable (the numbers on the diagonal of the correlation matrix in Table 3) was larger than the corresponding correlation coefficient. Thus, the discriminant validity of our measurement model was confirmed (Fornell & Larcker, 1981).

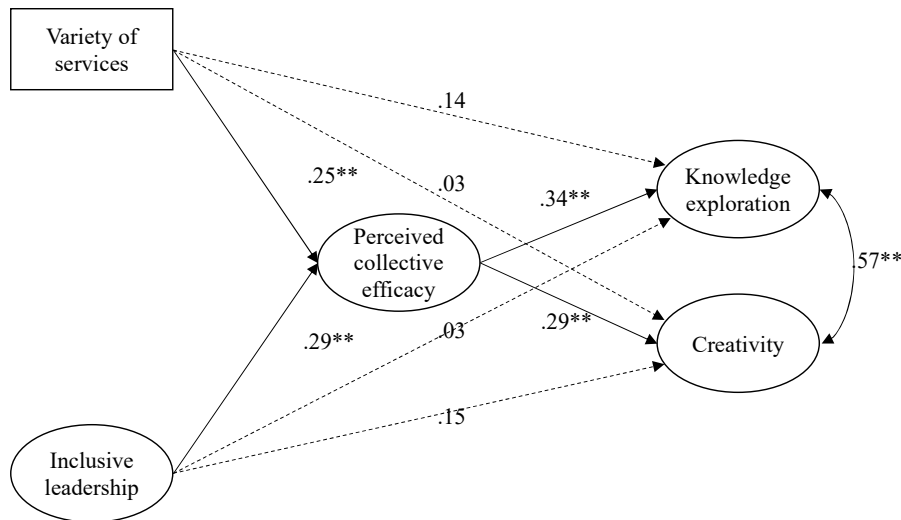
Table 3 Result of convergent and discriminant validity test

Latent variables	CR	AVE	Square root of AVE and correlation coefficient ^a			
			1	2	3	4
1. OIH's inclusive leadership	.90	.65	.80			
2. Perceived collective efficacy	.93	.71	.29	.85		
3. Knowledge exploration	.81	.51	.15	.33	.71	
4. Creativity	.80	.50	.19	.30	.51	.71

Note: n=134. ^aPearson's correlation coefficient.

4.2. Hypothesis testing

To test the hypotheses, we conducted the SEM analysis on the model representing the relationship between the OIH's operations (the variety of the OIH's service and the OIH's inclusive leadership), perceived collective efficacy, and employees' innovative behavior (knowledge exploration and creativity). Figure 1 shows the SEM results. The model showed an acceptable fit to the data: $\chi^2/df = 1.6$, RMSEA = .07, CFI = .93, TLI = .92, and SRMR = .06. The results revealed that: (a) the variety of the OIH's services and the OIH's implementation of inclusive leadership were significantly and positively related to the perceived collective efficacy ($\beta = .25, p < .01$ and $\beta = .29, p < .01$, respectively); (b) employees' perceived collective efficacy was significantly and positively related to employees' knowledge exploration ($\beta = .34, p < .01$) and creativity ($\beta = .29, p < .01$). Thus, Hypotheses 1 and 2 were supported. We observed no significance in the examinations considering potential effect of the development stage of the project on perceived collective efficacy, knowledge exploration, and creativity ($\beta = -.16, -.01$, and $-.09$, respectively).



Note: * $p < .05$, ** $p < .01$. Development stage of the project and passes from this variable are suppressed.

Figure 1 Result of the SEM analysis illustrating path estimates.

5. Discussion and Conclusion

5.1. Contribution to the literature

The existing research has suggested that an OIH facilitates the opening up of a company's innovation process (Kirschbaum, 2005; Kodama & Shibata, 2016; Lichtenthaler, 2008). However, this stream of research lacks an empirical and in-depth examination of the role of OIHs in sustaining and fostering OI initiatives. In particular, the behaviors of employees involved in OI projects have not been considered in this context. Hence, this study aimed to fill this research gap by providing a theoretical model based on social cognitive theory and empirically examining how OIHs facilitate employees' innovative behavior during the development of an OI project. Our findings from the survey, which investigated participants' behavior, collective efficacy, and the OIH's operation during their projects, reveal that the variety of OIHs' services and inclusive leadership positively relate to employees' perceived collective efficacy, and that this collective efficacy, in turn, facilitates employees' knowledge exploration and creativity. These results clearly indicate that the employees' belief and trust toward the company's aptitude to promote OI initiatives crucially influence their innovative behavior, hence sustaining the development of OI projects. Therefore, the primary contribution of this study is both a theoretical and empirical explanation of how an OIH promotes OI at the project level.

In particular, this study shows that the perceived collective efficacy can be a key concept for studying the management of OI projects. OI studies have around 20 years of history, but there are several unexplored research frontiers in the discipline (Bogers et al., 2017; Randhawa et al., 2016). In particular, there has been a significant call for studies on employees' behavior in OI projects and mechanisms that drive their behavior (Bogers et al., 2017; Lewin et al., 2011; Randhawa et al., 2016). The project management studies have revealed that a particular configuration of project management practices fosters performance of OI projects (Barbosa et al., 2021; Gomes et al., 2021). Building on these studies, our research reveals that perceived collective efficacy is a key link connecting an organizational solution and performance, that is., an organizational solution (such as the establishment and implementation of an OIH) affects employees' perceived collective efficacy; and these employees' perceived collective efficacy, in turn, influences their innovative behavior (as reflected by knowledge exploration and creativity). These results suggest that project members' belief in the OI capability of the organization as whole is a crucial determinant of project members' behavior.

Our study also contributes to the literature in at least two other ways by setting collective efficacy as a central construct of our explanatory model. First, our study extends prior research on the role of collective efficacy in facilitating employees' innovative behavior. As we have reviewed, previous studies have revealed that perceived collective efficacy facilitates employees' innovative behavior (Kim & Shin, 2015; Yaakobi & Weisberg, 2018). However, these studies have examined this relationship when employees are engaged in closed innovation projects, while OI projects are characterized by more complex inter-organizational and extra-organizational dynamics (Chesbrough & Crowther, 2006; Chiaroni et al., 2011; Grönlund et al., 2010). Our results indicate that perceived collective efficacy also facilitates employees' innovative behavior

in more complex scenarios. Therefore, our study not only confirms existing theory but also extends its relevance into the OI field.

Second, we empirically illustrate how an organizational solution influences individuals' belief in collective efficacy. The social cognitive theory argues that perceived collective efficacy is fostered by direct and vicarious support, social persuasion, and affective status (Goddard et al., 2004). However, the specific approaches to develop perceived collective efficacy have yet to be explored (Gibson & Earley, 2007). Our study reveals that the various services offered by the OIH provide opportunities for direct or vicarious support. It also shows that when an OIH exhibits inclusive leadership, it gives positive feedback and encouragement to the project members. These results contribute to the further development of collective efficacy theory.

5.2. Managerial implications

This study provides three main implications for managers who intend to capture the benefits of OI. First, we provide a guideline to establish OIH operations effectively. As revealed by our study, the variety of OIHs' services and OIHs' inclusive leadership facilitate perceived collective efficacy, which, in turn, promotes employees' innovative behavior. Thus, we recommend that OIH managers use these resources to make the most of the establishment of OIHs to support OI initiatives.

Second, our study provides managers with an effective approach to explore a novel way of managing OI projects. Indeed, as our study reveals, perceived collective efficacy is a key factor to foster innovative behavior of OI project members. Thus, this finding enables managers to focus on perceived collective efficacy of project members and explore other possible ways to foster it (Gibson & Earley, 2007). This approach potentially works as an effective guideline to explore a novel practice to manage OI projects.

Third, we suggest that the manager of an OIH should use perceived collective efficacy as a monitoring instrument. To evaluate the effects from the introduction of the OIH, managers must monitor employees' innovative performance. However, it takes a certain amount of time before the innovative performance becomes visible. As our study reveals, perceived collective efficacy is an antecedent of employees' innovative behavior in an OI project. Therefore, managers can use perceived collective efficacy as a performance indicator measurable using a convenient tool, such as a questionnaire, which is used in this study.

Additionally, this study provides an implication for science, technology, and innovation policy makers. As our study indicates, OIHs play a crucial role in facilitating OI project performances and policy makers should encourage firms to establish OIHs by, for example, governmental subsidies or tax exemption. Moreover, policy makers should establish public OIHs that support several firms, particularly small firms, in conducting OI projects.

5.3. Limitations and future research opportunities

The present study has at least three main limitations in terms of survey design. First, we conducted a cross-sectional, self-report survey to measure all variables, including employees' knowledge exploration, employees' creativity, perceived collective efficacy, and OIHs' inclusive

leadership. While we addressed the risk of CMV bias implicit with this form of survey by following the recommendations made by Podsakoff et al. (2003), future research may be able to employ different sampling approaches, such as the multi-source survey or the panel survey. Second, we measured collective efficacy based on the perception of each individual employee. Our method was justified by confirming that the intra-group variance was significantly larger than the inter-group variance, similar to previous studies (Cady et al., 2018; Goddard et al., 2004). Third, we did not design the survey assuming that multiple respondents belonged to the same single project. Future research should consider a study design with multiple responses per project. Ideally, future research can conduct a multi-level study by collecting data from more participants from a variety of companies or from various projects. Such multi-level studies should examine, for example, how the collective efficacy of project teams or OIHs affects employees' innovative behavior in OI projects.

This study also suffers from theoretical limitations. As our model incorporated a limited number of variables, future research may offer the opportunity to investigate the effects exerted by other variables and further elaborate on the model developed here. For example, we should consider including variables of project-related innovation performance to capture the phenomena specific to OI projects. By considering other variables that capture additional features of the OI project (such as the characteristics of the partners involved, the degree of radicalness of the innovation, and the type of innovation—whether it is a new product, service, or business model), future research can deepen the understanding of the phenomenon and assess whether the findings of our analysis can be extended to a broader category of OI projects. Moreover, future research may empirically examine how employees' behavior collectively fosters organizational capability of fully capturing the benefits of OI projects by employing the microfoundations perspective (Felin et al., 2015). Finally, as the context of Japanese companies may impact our findings (e.g., in terms of dominant culture), future research may theorize and test the impact of geographical variables on our model by conducting international comparative studies.

Note

- 1 We requested the participants to provide the project names they participated in. However, probably owing to confidentiality, most respondents answered using abstract project names, e.g., open innovation activities. Therefore, even when they provided the same project name, we could not conclude whether they participated in the same project. Thirteen respondents provided such responses (9.7%).

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Appendix. Items used to measure the study variables

Knowledge exploration ($\alpha = .80$)

- I search for new possibilities with respect to products/services, processes, or markets.
- I evaluate diverse options with respect to products/services, processes, or markets.
- I engage in activities requiring quite some adaptability of me.
- I engage in activities requiring me to learn new skills or knowledge.

Creativity ($\alpha = .75$)

- I demonstrated originality in my work.
- I solved problems that had caused other difficulty.
- I identified opportunities for new products/processes.
- I generated revolutionary ideas.

Perceived collective efficacy ($\alpha = .92$)

- Through open innovation, our company will realize a new business and/or innovation in the near future.
- Through open innovation, our company can solve problems that arise during new business development.
- Through open innovation, our company can effectively support new business development projects.
- Through open innovation, our company can discover a lot of promising business ideas.
- Through open innovation, our company can incubate ideas and develop them into actual business.

OIHs' inclusive leadership ($\alpha = .90$)

- People in the open innovation hub are attentive to new opportunities to improve work processes (openness).
- People in the open innovation hub are open to discussing the desired goals and new ways to achieve them (openness).
- People in the open innovation hub are available for consultation on problems (availability).
- People in the open innovation hub are ready to listen to my requests (availability).
- People in the open innovation hub are accessible for discussing emerging problems (accessibility).