

Impact of qualified gatekeepers on team absorptive capacity: the mediating role of knowledge combination capability

Xiang Yu, Yuichi Washida and Masato Sasaki

Abstract

Purpose – This study aims to examine direct effects of qualified team gatekeepers on absorptive capacity (AC), and the mediating roles of combinative capabilities – knowledge integration capability (KIC) and interteam coordination.

Design/methodology/approach – A social networking analysis was used to analyze a unique data set collected from all members of 32 Japanese research and development (R&D) teams to identify key individuals who perform daily gatekeeping functions. This study analyzed the data through partial least squares structural equation modeling with higher-order latent variables. Finally, cross-validation tests were used with holdout samples to test the model's predictive validity.

Findings – Qualified gatekeepers directly contribute to teams' realized AC but not to their potential AC. Furthermore, qualified gatekeepers can improve their teams' capability to absorb and exploit external knowledge by facilitating their capability to consolidate knowledge, that is, its KIC and interteam coordination.

Originality/value – Unlike prior research that asks top managers to identify team gatekeepers, this study used social network analysis to identify these vital individuals. This study provides a new framework indicating how qualified gatekeepers impact the AC of R&D teams through the examination of both the direct and indirect paths of gatekeeping abilities, two combinative capabilities as mediators and team AC.

Keywords Gatekeepers, Absorptive capacity, Combinative capabilities, Knowledge integration capability, Interteam coordination, Social network analysis

Paper type Research paper

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1. Introduction

Firms are increasingly opting to utilize research and development (R&D) teams to execute innovation activities. Therefore, these teams need the capability to acquire, assimilate, transform and exploit external knowledge (knowledge that resides in the external environments, outside of the firms) to recognize market opportunities for providing valued products and services before competitors in the modern dynamic environment (Badir *et al.*, 2020; Hertenstein and Williamson, 2018). Cohen and Levinthal (1990) first coined the term “absorptive capacity” (AC) to describe this vital capability. Since then, a considerable number of empirical and conceptual studies have contributed to the understanding of this concept (Apriliyanti and Alon, 2017; Chaparro *et al.*, 2021). However, there remains scant empirical efforts investigating how to break down the process of absorbing and using external knowledge among individuals (Badir *et al.*, 2020; Ter Wal *et al.*, 2017). Thus, the limited understanding of the team AC process begs the question “whether members in a team should better specialize in certain processes or rather work as generalists dedicated to a range of absorption efforts” (Ter Wal *et al.*, 2017, p. 1039).

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This question might be answered by investigating the role of gatekeepers (Ebers and Maurer, 2014; Schillaci *et al.*, 2013; Ter Wal *et al.*, 2017). Based on the original gatekeeping theory, some researchers believe that gatekeepers play a vital role in organizational AC by monitoring the external environment of the company, searching for valuable external knowledge and communicating it to the rest of the members in an understandable way, while others focus on the exploitation of this knowledge (Cohen and Levinthal, 1990; Daghfous, 2004; Schillaci *et al.*, 2013). These arguments lead to an implicit consensus that gatekeepers mainly contribute to the acquiring and assimilating parts of AC.

However, gatekeepers may undertake more complex roles in the process of AC. For instance, Cohen and Levinthal (1990) emphasized that “relying on a small set of technological gatekeepers may not be sufficient” and “the group as a whole must have some level of relevant background knowledge [...] for effective communication with the gatekeeper” (p. 132). That is to say that members need related prior knowledge to ensure the transformation and exploitation of the external knowledge that gatekeepers transmitted to them. Nevertheless, individuals may not access required background knowledge because of the restriction of limited personal knowledge base and thus need to absorb it from other colleagues (Cohen and Levinthal, 1990; Jansen *et al.*, 2005; Todorova and Durisin, 2007). Consequently, the teams’ ability to transform and exploit external knowledge is also strongly affected by the abilities of combining internal knowledge (knowledge that resides within the firms, including knowledge within the teams and knowledge in other teams) (Balle *et al.*, 2020; Jansen *et al.*, 2005). Considering that qualified gatekeepers perform internal-networking roles (Whelan *et al.*, 2010), facilitating internal knowledge combination (Cross and Prusak, 2002; Huang *et al.*, 2018), they may also undertake the role of supporting other members’ knowledge transforming and exploiting activities by making their internal knowledge accessing activities more effective. From this perspective, gatekeepers may also be vital for the transformation and exploitation parts of their team’s AC.

This “coach” role may become vital in the acquiring and assimilating parts of team’s AC in modern R&D context. Specifically, researchers argued that in modern knowledge-based society, the external knowledge searching and introducing activities may be deconcentrated and divided by each member (Whelan *et al.*, 2010; Whelan *et al.*, 2013). Qualified gatekeepers thus can support their colleagues’ external knowledge absorbing and assimilating activities through facilitating the efficiency of their internal knowledge-accessing activities, and eventually the acquiring and assimilating parts of team’s AC. Nevertheless, despite that the positive effect of gatekeepers’ AC has already been quantitatively verified (Huang *et al.*, 2018; Ter Wal *et al.*, 2017), empirical effort paid to systematically explore and verify the roles of qualified gatekeepers is, to the best of our knowledge, remain scarce. Therefore, this article aims to answer the research question “what are the roles of qualified gatekeepers in the AC process?”

It is reasonable to believe that qualified gatekeepers contribute to AC directly by introducing and transmitting new knowledge outside of the company. They may also indirectly affect their teams’ AC by supporting other members’ knowledge absorption and exploitation activities. This study thus develops a theoretical model including both the direct effect of qualified gatekeepers on team’s AC and the mediating effect of teams’ knowledge combination capabilities to answer our research question. We collected data from 32 teams in two famous high-tech manufacturing labs in Japan to testify our model. These teams’ main task is to identify market opportunities through searching the marketing knowledge (such as knowledge about new demands and preferences of business clients or typical customers, recent tendencies of rivals and suppliers and advanced marketing techniques about how to transform prototypes into final products and sell them at the correct price, place and promotion) and the new technology trends, develop their cutting-edge technologies (such as robotics technology, control

engineering with information technology, electrical and electronic engineering technology and so on), search and introduce complement technologies and eventually combine them into the final prototype.

The study contributes to the literature in the following ways. First, this study's micro-level investigation is novel because AC is ultimately the team process and routine generated from combinations of its members' activities related to the absorption and exploitation of external knowledge (Murtic *et al.*, 2018). Although examining AC at the micro-level has grown in recent years (Lowik *et al.*, 2016; Majhi *et al.*, 2020), most of these studies, which mainly focus on the effect of team members' characters, overlook their roles and activities. This omission results in a lack of understanding of how this concept can best be deconstructed among individuals, eventually leading to the problem of reification (Martinkenaite and Breunig, 2016). By investigating the mechanisms between gatekeepers and teams' AC, this study clarifies individuals' roles in external knowledge acquisition and exploitation, thus extending the understanding of the AC process.

Second, this study contributes to the literature on knowledge management (KM). Although the internal knowledge combination has been regarded as a critical part of KM and has recently been recognized and empirically tested (Gonzalez, 2021; Nur *et al.*, 2019), the empirical efforts paid to investigate the antecedents and outcomes of this concept remain insufficient. By demonstrating the mediating role of an organization's knowledge combination capability in the relationship between qualified gatekeepers and AC, this study unravels the prominent figure in its development, and highlights its potential significance to individual growth. Third, the study contributes to updating of existing gatekeeping theories. Except for some special cases (Hung, 2017; Whelan *et al.*, 2010), gatekeepers, despite their relevance, have received less research attention than they may deserve. By investigating the roles of qualified gatekeepers in the AC process, this study sheds light on the aforementioned questions and thus contributes to the accumulation and update of related theories.

The rest of the paper is structured as follows. First, the theoretical hypothesis model is established based on a literature review of AC, gatekeepers and knowledge combination capability. Next, the research setting, data collection and measurements and results of the analysis are presented. Finally, the conclusions, implications and limitations of this study are discussed.

2. Literature review

2.1 Absorptive capacity

The concept of AC was first introduced by Cohen and Levinthal (1990) and defined as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (p. 128). Since then, many empirical efforts have been made to investigate the nature, components, antecedents and outcomes of this concept. One of the reasons for the richness of this construct is its overlap with other popular theories such as organizational learning theory, social cognitive theory, resource dependence theory, social network theory, dynamic capability theory and KM theory (Apriliyanti and Alon, 2017; Lane *et al.*, 2006). To better capture the accomplishments of a broad range of previous studies and the current state of AC research, prior studies were divided into four main streams based on four vital reviews in this field (Apriliyanti and Alon, 2017; Duchek, 2013; Volberda *et al.*, 2010). The details of which are shown in Table 1.

Studies on the natural stream have demonstrated that AC is a higher-order dynamic capability comprising four dimensions: acquisition, assimilation, transformation and exploitation. Acquisition denotes routines and processes used to monitor external knowledge, evaluate the potential of new knowledge that external parties possess and

Table 1 The research streams on AC

<i>Stream(s)</i>	<i>Purpose(s)</i>	<i>Representatives</i>
The nature of AC	Investigating the definition, dimensions, components and measurements of AC; investigating contingency antecedents/outcomes of these components.	Cohen and Levinthal (1990); Zahra and George (2002), Jansen <i>et al.</i> (2005); Lane <i>et al.</i> (2006), Todorova and Durisin (2007); Murovec and Prodan (2009)
Intraorganizational learning	Investigating the relationships of AC and internal learning process; investigating the antecedents of the organizational learning of AC.	Cohen and Levinthal (1990); Andersson <i>et al.</i> (2016), Darwish <i>et al.</i> (2020)
Social networks	Investigating how AC can help firms better develop interorganizational networks and benefit from them; investigating the effect of social networks on AC.	Lane and Lubatkin (1998); Miller <i>et al.</i> (2016); Mei <i>et al.</i> (2019); Kurniawan <i>et al.</i> (2020)
Inter and intraorganizational knowledge sharing	Investigating the casual mechanisms between Inter- and intraorganizational knowledge sharing and AC.	Jansen <i>et al.</i> (2005); Junni and Sarala (2013); Berry (2017); Balle <i>et al.</i> (2020)

quickly access it when necessary (Flatten *et al.*, 2011; Todorova and Durisin, 2007). Assimilation refers to the ability to analyze, interpret and understand acquired knowledge (Marabelli and Newell, 2014). Transformation is based on organizational routines that help an organization construct new cognitive structures by integrating assimilated external knowledge into the existing knowledge base (Zahra and George, 2002). Exploitation refers to a firm's ability to apply transformed knowledge to final products, services or systems (Flatten *et al.*, 2011; Zahra and George, 2002). These four dimensions are then grouped into two separate but complementary subsets: potential AC (PAC) and realized AC (RAC) (Jansen *et al.*, 2005; Zahra and George, 2002). The former represents knowledge acquisition and assimilation, while the latter includes the ability of an organization to transform and exploit external knowledge. This multifaceted character of AC also differentiates the effects of a specific organizational antecedent to AC depending on which component is analyzed (Jansen *et al.*, 2005; Van den Bosch *et al.*, 1999). Based on these findings, the following research empirically testifies the antecedents, outcomes, mediating and moderating effects of AC in the context of intraorganizational learning, social networks and inter- and intraorganizational knowledge sharing.

Recent research noticed that the specific processes and routines of AC remain a "black box" (Martinkenaite and Breunig, 2016), and therefore turned their attention into investigating AC at micro individual and team levels. Through a bibliometric analysis of 2,088 papers from 1990 to 2015, Apriliyanti and Alon (2017) also noticed this growing micro-foundation stream and Table 2 lists some critical studies on this. In sum, one of the objectives of current AC research is to investigate the development of AC at individual and team levels. Nevertheless, recent research emphasizes the effect of individuals' characters rather than their activities, leaving the roles that individuals play in the processes of external knowledge acquisition, assimilation, transformation and exploitation unclear (Rafique *et al.*, 2018; Ter Wal *et al.*, 2017). Considering that investigating the role of gatekeepers can help us better understand individuals' roles (Ebers and Maurer, 2014; Schillaci *et al.*, 2013; Ter Wal *et al.*, 2017), we believe that probing the relationships between qualified gatekeepers and team-level AC is necessary to overcome this limitation and achieve forementioned objective. In addition, the combined effect of individual and team-level factors on the team-level AC also needs further investigation (Martinkenaite and Breunig, 2016; Ojo *et al.*, 2017). Investigating the potential mediating role of knowledge combination capability, which is thought to be one of AC's most vital team-level antecedents (Lowik *et al.*, 2016; Ojo *et al.*, 2017), in the relationships between qualified gatekeepers and team-level AC, is necessary to achieve the aforementioned goal.

Table 2 Main studies investigating AC micro-foundations

<i>Authors</i>	<i>Objective(s)</i>	<i>Effect factors studied</i>	<i>Analytical method</i>	<i>Research context/sample</i>
Siachou and Gkorezis (2014)	Investigate individual level antecedents of individuals' AC	Psychological empowerment	Multiple regression analysis; usefulness analysis	Survey of 100 private employees working at two manufacturing organizations
Ebers and Maurer (2014)	Investigate micro-foundations of organizations' PAC and RAC	Organizational boundary spanners' external and internal relational embeddedness and their relational empowerment	Maximum likelihood estimation of Structural Equation Modeling (SEM)	Project managers of 218 projects at 144 firms in German mechanical engineering and plant engineering industries
Lowik <i>et al.</i> (2016)	Investigate combined effect of individual and organizational factors on teams' AC	Individuals' ACAP; team-level social integration mechanisms	PLS-SEM; fs/QCA	Survey of 297 employees of four medium-sized Dutch firms, working in 48 functional teams
Ojo <i>et al.</i> (2017)	Investigate micro-level antecedents of asymmetric joint project engineering teams' AC	Individuals' prior experience and need for cognition; team-level shared cognitive capability	SEM	Survey of 248 local employees from 76 joint project engineering teams in the Nigerian upstream oil industry
Rafique <i>et al.</i> (2018)	Investigate the impact of employees' behavior on development of absorptive capacity	Knowledge sharing; learning adaptability; organizational commitment	Multiple regression analysis	Survey of 170 respondents from pharmaceutical firms in Pakistan
Yildiz <i>et al.</i> (2019)	Investigate individual-level antecedents of individuals' AC in the context of MNCs	Individuals' work motivation, ability and opportunity	SEM	Survey of 648 engineers working across a range of different functional areas at a large European multiunit manufacturing MNC
Pratoom (2022)	Investigate the teams' goal orientations on individuals' AC and the moderating effects of transformational leadership climate in this process	Three teams' trait goal orientations (mastery, performance-prove and performance-avoid goals)	Multilevel method	Survey of 480 members in 76 teams from accounting firms in Northeast Thailand

2.2 Gatekeeping theory

The term gatekeeper is firstly identified by Lewin (1947) to describe individuals who control information flows to manipulate the result of decision-making. Allen and Cohen (1969) first introduced this concept into R&D context by identifying the existence of "gates" in R&D labs as being individuals "who perform boundary-spanning roles in the laboratory; that is, those, to whom others in the laboratory most frequently turn for technical advice and consultation, will show more contact with technical activity outside of the laboratory" (p. 13). Allen (1977) used the term "technology gatekeepers" to describe these vital individuals. Tushman and Katz (1980) demonstrated that qualified gatekeepers can facilitate technology development projects through the development of internal and external relationships. Harada (2003) stated that gatekeeping activities may be performed by members highly connected with the external world and members highly connected internally. Whelan *et al.* (2010) reported that gatekeeping activities can be carried out jointly by external and internal communication stars.

Prior studies (Huang *et al.*, 2018; Walsh, 2015; Whelan *et al.*, 2013) identified three vital functions of gatekeepers: they serve as the team's antennae to scan the outside world for the acquisition of emerging new knowledge relevant to their labs' current project (Allen, 1977; Allen and Cohen, 1969); they translate valuable external knowledge into a form that can be understood by other colleagues (Macdonald and Williams, 1993); they disseminate

the translated knowledge to their colleagues for the use (Whelan *et al.*, 2013). In sum, the current literature in this field believes that the contribution of gatekeepers “stops after they share the information they acquired” (El Samra, 2021, p. 4). This is why AC researchers argue that gatekeepers mainly contribute to the acquisition and assimilation parts of organizational AC (Cohen and Levinthal, 1990; Daghfous, 2004; Schillaci *et al.*, 2013; Tzeng, 2021).

Nevertheless, the role of gatekeepers is highly likely to be evolving, and their contributions may not stop at the acquisition and assimilation parts, as current research suggested (El Samra, 2021). For instance, based on a case study of an Irish R&D unit in a multinational telecommunications company, Whelan *et al.* (2013) found that gatekeepers are “highly sociable with very good networking skills enabling them to develop extensive internal and external networks” (p. 207). From this point, gatekeepers may also perform an internal-networking role, which can help their colleagues access and combine internal knowledge in the company more effectively and eventually facilitate the efficiency of their teams’ transformation and exploitation activities. In addition, considering that gatekeepers are those who are highly talented (Allen and Cohen, 1969; Messeni Petruzzelli *et al.*, 2010), and enjoy helping others (Whelan *et al.*, 2013), they may also act as a consultant, making their colleagues more capable for knowledge transformation and exploitation. In conclusion, further exploration of the gatekeepers’ overall role is one of the objectives in this field. Based on the above arguments, we believe investigating how gatekeepers affect organizational knowledge combination, and AC could effectively accomplish this objective.

2.3 Knowledge combination capability

It has been largely agreed that the combination of internal knowledge distributed among companies’ specialized individuals is a central problem for knowledge-based companies’ management (Kogut and Zander, 1992). However, the specialization of knowledge creates boundaries among individuals and internal suborganizations, leading the combination mentioned above process extremely difficult (Postrel, 2002). Consequently, the capability to exchange knowledge among specialized individuals and work teams within the company is needed (Nur *et al.*, 2019). Prior research used the term knowledge combination capability to describe processes and routines that help organization members absorb and combine knowledge of an entire company (Carmeli and Azeroual, 2009; Smith *et al.*, 2005). At the team level, knowledge combination capability can help team members absorb and integrate knowledge initially held by certain team members, as well as knowledge residing in other teams within the company. The former can be described by the term “knowledge integration capability” (KIC) (Gardner *et al.*, 2012; Zahra *et al.*, 2020), while the latter can be encompassed by the concept “inter-team coordination” (IC) (Hoegl *et al.*, 2004).

Knowledge combination capability is essentially different from AC, even though it may seem similar (Berggren *et al.*, 2016; Carmeli and Azeroual, 2009; Ruiz-Jiménez *et al.*, 2016). The theory of AC focus on investigating how organizations acquire, assimilate, transform and exploit new knowledge from external environment of the company. Cohen and Levinthal (1990) emphasized that organizations cannot absorb new knowledge without related background knowledge. AC is thus a kind of capability related to the accumulation of knowledge in a specific domain. For instance, with the help of AC, an R&D team can effectively understand and evaluate a new technology from a college based on the existing background knowledge in this discipline. Once this new knowledge is transformed and combined with existing knowledge, the depth of the knowledge base will be enlarged, leading the subsequent absorption of new technology in this discipline easier. In this context, AC is the ability to contribute to the depth of teams’ knowledge base.

On the other hand, knowledge combination capability focuses on integrating differentiated knowledge held by specialized firm’s employees (Berggren *et al.*, 2016; Carmeli and Azeroual, 2009). By relying on the knowledge combination capability, an R&D team can

combine differentiated knowledge held by both internal team members and members in other teams and eventually form a knowledge base with a broad array of disciplines (Distel, 2019). In essence, the ability of knowledge combination mainly results in the scope expansion of teams' knowledge base. Figure 1 provides a depiction of the differences mentioned above.

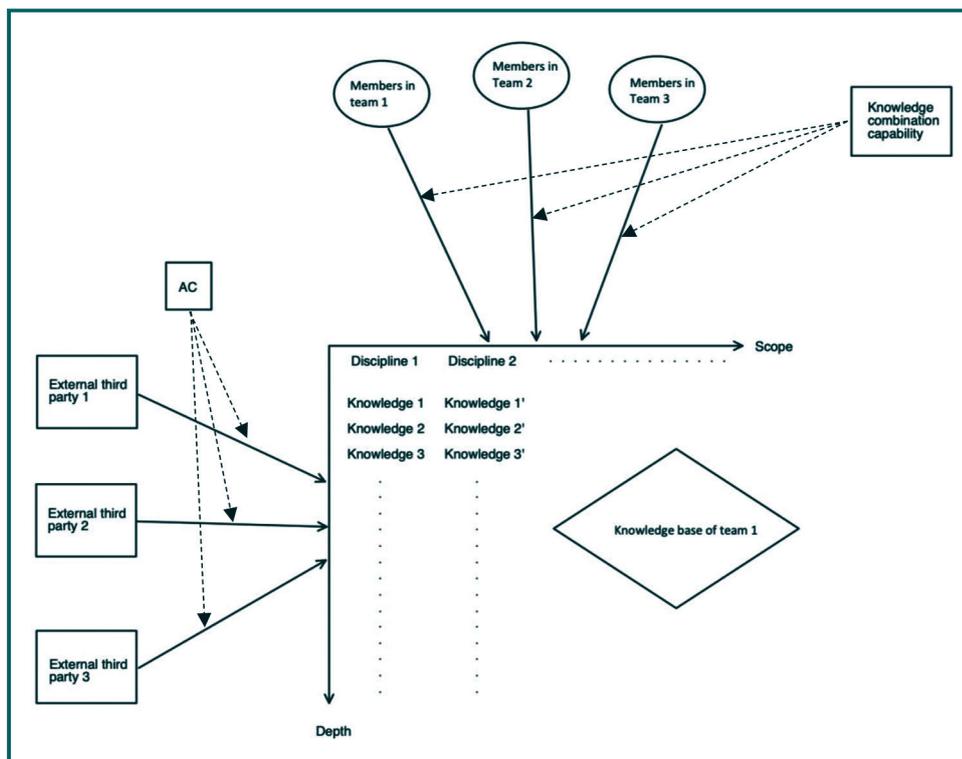
To achieve the objectives above, we developed a novel research model including the mechanisms between gatekeepers' abilities, team-level knowledge combination capability and team-level AC in the following section.

3. Hypothetical model

3.1 Direct effect of qualified gatekeepers on teams' absorptive capacity

Gatekeepers' knowledge-acquiring abilities can help their organizations search for and acquire external knowledge (Allen, 1977; Allen and Cohen, 1969; Ettlie and Elsenbach, 2007; Tushman and Katz, 1980). Specifically, they may act as antennae that scan the outside world to capture and absorb valuable new knowledge (Whelan *et al.*, 2010). Involvement in these external searches makes it possible for gatekeepers to frequently interact with a diverse range of external third parties or other teams. Consequently, qualified gatekeepers tend to have abundant experience in interacting with external organizations. Furthermore, they have high-value external networking skills and strong ties and trusting relationships with external organizations (Ebers and Maurer, 2014; Whelan *et al.*, 2010). Moreover, frequent interaction with outsiders can help gatekeepers build more reflective routines and networks for processing knowledge, which, according to prior research (Zahra and George, 2002), can contribute to the organization's PAC. Through frequent external interaction, gatekeepers can also "coach external organizations to communicate external

Figure 1 Difference between knowledge combination capabilities and AC



knowledge in ways that facilitate subsequent internal assimilation" (Ter Wal *et al.*, 2017, p. 1044) and therefore further enhance their own team PAC. Moreover, they can also quickly identify which external actors may have access to new knowledge that their team needs, to introduce more valuable new knowledge and ideas to their own team (Ebers and Maurer, 2014). Furthermore, the greater the trust developed, the more willing they are to share their knowledge (Uzzi and Lancaster, 2003) and motivate receivers to acquire knowledge from them (Wu, 2008). In this regard, qualified gatekeepers can promote the introduction of external knowledge into the team, thus promoting team PAC.

Gatekeepers' activities of translating knowledge into an understandable form and passing it on to other team members who may need it facilitates the receipt of valuable external knowledge with diverse coding schemes (Allen and Cohen, 1969; Harada, 2003; Tushman and Katz, 1980; Whelan *et al.*, 2010). Qualified gatekeepers are thus highly capable of disseminating knowledge to other team members in a way that they understand. Through this process, the gatekeepers will also explain why they think the knowledge is valuable and how it can be applied to the current project. From this perspective, members of a team that comprises qualified gatekeepers can easily assimilate, internalize and utilize external knowledge without much time and effort. Consequently, teams' PAC and RAC are facilitated. In addition, by showing how to find links that will combine new knowledge with existing knowledge and projects, qualified gatekeepers can provide experience and know-how related to the transformation and exploitation of new knowledge to other members. This kind of "on the job training (OJT)" effect will benefit teams' RAC. Moreover, there is a gap between the time the knowledge was acquired and the time it was needed. Therefore, qualified gatekeepers may serve as a "knowledge pool" with an abundance of translated external knowledge (Ter Wal *et al.*, 2017), facilitating both the depth and breadth of their team's prior knowledge base. Prior research (Cohen and Levinthal, 1990; Ojo *et al.*, 2017) has demonstrated that relevant prior knowledge is the foundation of both PAC and RAC. It is, therefore, reasonable to suppose that a qualified gatekeeper contributes to his or her team's PAC and RAC.

Qualified gatekeepers also possess the ability to access internal networks to perform the aforementioned translation and dissemination activities (Whelan *et al.*, 2010). For example, Cross and Prusak (2002) stated that the "go-to" character indicated by Allen and Cohen (1969) may make gatekeepers a central connector linking other individuals. In a case study of an R&D group at a medical device manufacturing firm, Whelan *et al.* (2010) demonstrated that gatekeepers access high-level networking and thus can help their organizations develop extensive internal networks. Dahlander *et al.* (2016) found that individuals who engage in external knowledge searches also make such efforts internally. Similarly, Ebers and Maurer (2014) reported that qualified gatekeepers can access strong ties and trust relationships with other team members. From this perspective, qualified gatekeepers promote knowledge sharing within the team and are thus more aware of what kinds of knowledge other members need. As a result, their external knowledge search and dissemination activities can be more effective, leading to greater team PAC. In addition, acting as a "technology consultant," qualified gatekeepers can also teach other members how to internalize and use new technological knowledge, therefore, facilitating the efficiencies of their further transformation and exploitation activities. Consequently, teams with qualified gatekeepers are likely to consist of individuals with high transformation and exploitation abilities, and therefore high RAC.

In conclusion, qualified gatekeepers may directly contribute to their teams' PAC and RAC by introducing external knowledge on their own and facilitating the performance of other team members' new knowledge assimilation, transformation and exploitation activities. Hence, the following hypothesis is proposed:

H1. Gatekeepers' abilities have a positive direct effect on teams (a) PAC and (b) RAC.

3.2 Mediating role of knowledge combination capability

Qualified gatekeepers may also help their teams develop a higher knowledge combination capability, which can support other team members in better absorbing and implementing external knowledge. This supporting role of qualified gatekeepers should also be noted because it is extremely difficult for a team to rely on only a few “superheroes” to obtain all necessary new knowledge, particularly in our modern knowledge-based society where knowledge of various domains is vital. Therefore, this study also focuses on the indirect effects that qualified gatekeepers have on team AC through mediating these two knowledge combination capabilities.

3.2.1 Mediating effects of knowledge integration capability. Qualified gatekeepers can help improve a team’s capability of combining the knowledge of each team member and improving the team’s KIC. As qualified gatekeeper enhance internal network relationships using their internal networking skills, members of a team with highly qualified gatekeepers tend to have strong ties and trust (Hung, 2017).

Internal interactions ties can help members become aware of the existence and value of other members’ knowledge (Smith *et al.*, 2005), facilitate their common understanding (Reagans and McEvily, 2003; Tekleab *et al.*, 2016) and thus enhance the internal transfer of complex and tacit knowledge (Evans *et al.*, 2019; Fonti and Maoret, 2016). Consequently, knowledge sharing within a team can be enhanced (Nakauchi *et al.*, 2017). The vital effect of these strong member–member network ties on internal knowledge integration has already been largely demonstrated (Akhavan and Mahdi Hosseini, 2016; Hung, 2017; Jiafu *et al.*, 2018). One may argue that organizational ties could be easier to develop and maintain and thus can happen without gatekeepers. However, developing and maintaining these social interaction ties is much more difficult in R&D teams than in traditional teams (Gagné *et al.*, 2019; Jiang and Xu, 2020). Specifically, typical members on R&D teams are likely to suffer workplace stress (Zhao and Jiang, 2021), perceived time pressure and burnout generated from technology exposure (Bodensteiner, 1989; Salanova and Schaufeli, 2000; Škerlavaj *et al.*, 2018) and therefore have limited time and energy to devote to developing interaction ties with others. From this perspective, gatekeepers, who access high-level social skills, are indispensable for developing and maintaining internal interaction ties. Trust, as discussed above, can promote both the willingness of senders to share their knowledge and increase the motivation of receivers to acquire and evaluate it. Thus, knowledge can be integrated more easily by a team whose members trust one another (Buvik and Tvedt, 2017; Hau *et al.*, 2013; Evans *et al.*, 2019). Moreover, organizations with strong internal network ties and trusting relationships normally have access to high social capital, which may positively affect the behavior and attitude of team members and encourage them to share knowledge (Bartsch *et al.*, 2013), thus enhancing internal knowledge and combination knowledge sharing (Maurer *et al.*, 2011; Sargis Roussel and Deltour, 2012).

The gatekeepers can contribute to the internal knowledge combination even if the internal networks have already been developed and maintained. Based on prior research, networks in R&D organizations are normally asymmetric and heterogeneous (Abu-Ata and Dragan, 2016; Jiafu *et al.*, 2018). Consequently, one member in an R&D team is not likely to have linkages with all other colleagues. Based on the theory of structure hole, the knowledge sharing between two members who have no direct links can be achieved by a member they both connect with (Burt, 2002). In this sense, knowledge can be transferred and combined more effectively when a specific individual acts as a structure hole (Zhao and Jiang, 2021). Based on prior research, the gatekeepers normally occupy the central position and perform the role of filling the hole between two actors (Li *et al.*, 2020; Zacharias *et al.*, 2021). In addition, considering different education background experiences that typically characterize members in an R&D team and subdisciplines (Berends *et al.*, 2006; Hobman *et al.*, 2004), sending knowledge that receivers are unfamiliar with can be costly, difficult

and time-consuming. Individuals may have low motivation to share their knowledge with their colleagues. Based on the arguments of [Whelan et al. \(2013\)](#), gatekeepers who have a wider knowledge base and act as technology consultants are likely to access and understand the diverse knowledge held by other colleagues. They are also likely to pass the knowledge from one colleague to others because they enjoy helping others. In this sense, an R&D team can be more capable of integrating its members' knowledge with the help of its gatekeepers. Based on foregoing reasons, we propose the following hypothesis.

H2. Gatekeepers' abilities will have a positive effect on team KIC.

This enhanced KIC may further increase the level of PAC. KIC is “[...] an organizational capability for creating novel combinations of different strands of knowledge [...]” ([Zahra et al., 2020](#), pp. 10–11) and brings about reliable communication and collaborative interaction ([Gardner et al., 2012](#)). Through such reliable intracommunication, knowledge sharing can be more effective ([Jafari Navimipour and Charband, 2016](#)). Effective internal knowledge sharing is vital for acquiring and assimilating external knowledge ([Balle et al., 2020](#); [Mustafa et al., 2016](#); [Rafique et al., 2018](#)). Specifically, as mentioned in the literature review part, individuals cannot evaluate, introduce and assimilate new external knowledge without having background knowledge. Considering that the individuals' knowledge base is normally limited, they may not have that knowledge and might access it from other colleagues ([Cohen and Levinthal, 1990](#); [Jansen et al., 2005](#); [Todorova and Durisin, 2007](#)). For example, a member may not introduce an image recognition technology critical for the current project because they have little background knowledge of artificial intelligence. However, suppose the team they belong to has high KIC, and one of their colleagues has abundant knowledge and experience in this field, in that case, they can easily access related knowledge from that colleague and use it to absorb that vital image recognition technology. Thus, we suppose an R&D team with high KIC is more capable of absorbing and assimilating external knowledge than those with low KIC.

Meanwhile, the transformation and exploitation of RAC requires a common cognitive structure and transactive memory ([Cao and Ali, 2018](#); [Von Briel et al., 2019](#); [Zahra and George, 2002](#)), which can be facilitated by effective communication ([Argote et al., 2018](#); [Lewis, 2004](#)). Collaborative interactions, on the other hand, can promote effective discussion among team members, encourage them to share doubts, accept other colleagues' opinions ([Kozłowski, 2018](#)) and eventually help team members get a variety of internal knowledge from each other. With this extended knowledge base, individuals can better transform and apply external ideas ([Kang and Lee, 2017](#)). Furthermore, evidence shows that knowledge gained from other colleagues through the knowledge integration process can facilitate the team's absorption, storage and exploitation of knowledge ([Gardner et al., 2012](#)). Moreover, cooperation among team members can promote the development of a common understanding about appropriate team actions ([Ooms et al., 2015](#)), facilitate similar beliefs and perspectives about the team's operating conduct ([Verona, 1999](#)) and thus promote absorption and exploitation ([Jansen et al., 2005](#)). Based on aforementioned arguments, we propose the following hypotheses:

H3. Team KIC will have a positive effect on teams' (a) PAC and (b) RAC.

This study also posits that KIC functions as the mechanism through which qualified gatekeepers indirectly affect the level of their teams' AC. Specifically, in the modern internet- and knowledge-based society, the access of new external information has become easier, and the gap between the education level of individuals has been largely reduced. This is particularly noticeable in the context of R&D teams because R&D teams typically consist of highly educated and qualified specialists. Furthermore, organizations need more complex knowledge to keep up with current dynamic markets. Consequently, not only do individuals transform and exploit external knowledge brought by gatekeepers, but they themselves may also play a vital role of searching for and introducing new knowledge from

environments outside of the firms (Distel, 2019; Sjödin *et al.*, 2019; Whelan *et al.*, 2010; Whelan *et al.*, 2013; Yao and Chang, 2017). Based on the original suggestions by Cohen and Levinthal (1990), the prior related knowledge in a given field can help individuals generally understand the basic ideas, techniques and traditions of a specific discipline and therefore provide them with the basic skills and abilities to recognize and understand a new type of external knowledge in that discipline, store it in their memory and recall and apply it. An individual therefore cannot absorb, assimilate and utilize a specific piece of new knowledge without having the related basic knowledge. Nevertheless, considering that members on R&D teams are experts in different-but-related fields, the knowledge base of each member is typically limited, and the basic knowledge required may be resolved based on the knowledge base of other colleagues. When knowledge is shared within teams, information held by each member is combined into each team's knowledge base, leading to easier access to other members' knowledge. Nonetheless, for the reasons mentioned above, members in R&D are not likely to have sufficient time and energy to take the initiative to organize and manage knowledge sharing with other colleagues, leading to a low degree of knowledge sharing on R&D teams. This dilemma can be largely overcome with the use of qualified gatekeepers. Specifically, such gatekeepers are passionate about helping other colleagues through facilitating debates and experience exchanges or simply bringing their knowledge to others who may need it (Whelan *et al.*, 2010; Whelan *et al.*, 2013). Consequently, not only can qualified gatekeepers directly contribute to their teams' PAC and RAC, but they can also enhance their contributions through facilitating knowledge sharing and combination within their teams. Hence, the following hypothesis is proposed.

H4. Team KIC mediates the impact of gatekeepers' abilities on (a) PAC and (b) RAC.

3.2.2 Mediating effects of interteam coordination. Qualified gatekeepers can also promote team IC. As discussed above, qualified gatekeepers can have more interaction and build trusting relationships with external organizations, coach them to transform knowledge in ways that may facilitate subsequent assimilation, build more effective knowledge exchange networks and eventually promote knowledge sharing with them. These external organizations include both external third parties and other teams within the company. From this perspective, teams tend to coordinate, communicate and exchange knowledge with other teams more easily when qualified gatekeepers have already developed external social networks. In this sense, qualified gatekeepers can promote team IC. In addition, even if the networks have already been developed, an R&D team may still be able to coordinate with other teams effectively without knowledge protection regulation (Lee *et al.*, 2017; Mors, 2010). Knowledge protection regulation is a set of rules deciding which knowledge should be disclosed, which knowledge should be kept for their use and which knowledge of other teams should not be introduced. As discussed above, gatekeepers are originally defined as a group of people who determine a group's decision-making by controlling information flows. From this perspective, gatekeepers can contribute to developing knowledge protection regulation and eventually facilitate IC. Šmite *et al.* (2017) also confirmed that some specific "contact people" can communicate knowledge between teams as formal experts. Based on the above reasons, we hypothesize:

H5. Gatekeepers' abilities will have a positive effect on team IC.

In turn, IC can improve a team's capability to absorb and assimilate knowledge from external third parties. Specifically, coordination with other teams can provide appropriate knowledge to a team at the right time, which allows the team to easily access knowledge held anywhere within the knowledge base (Bjarnason *et al.*, 2022; van Rijnsoever *et al.*, 2008). In addition, IC can help team members better understand other teams' functional perspectives and wider organizational contexts (Bunderson and Sutcliffe, 2002), thus promoting knowledge exchanges with specialists on other teams (Ghobadi and D'Ambra, 2013). This combination of other teams' knowledge can enhance the team's knowledge base's scope, thus decreasing the mismatch between external knowledge and internal

knowledge base. In essence, the ability of a team to cooperate with other teams can help that team better value and incorporate new knowledge (Bendig *et al.*, 2018), and thus facilitate PAC of that team. Based on these arguments, the study hypothesizes:

H6. Team IC will have a positive effect on the team PAC.

R&D teams typically have their own specialized R&D themes and goals in different fields. Consequently, the disciplines or areas included in the knowledge based of a specific R&D team are highly likely to differ from those of the knowledge residing in other teams. As mentioned above, R&D teams occasionally need to absorb brand new knowledge. To do so, they must access related background knowledge, which is highly likely to reside in other teams. For instance, R&D teams are more likely to recruit science specialists – such as in artificial intelligence, mechatronics engineering, or machine learning – instead of those majoring in marketing or management. With limited prior marketing knowledge, members in R&D may fail to sufficiently evaluate and understand new information related to customer demands or marketing tools that may be critical for changing the direction and efficiency of the overall prototyping process. To grasp this critical knowledge, members must coordinate with other teams – especially those who are not in an R&D context – to access the required background marketing knowledge. In sum, R&D teams count largely on the IC to reduce the likelihood of a mismatch between critical external knowledge and their internal prior knowledge base. Despite the critical role of IC, coordinating with other teams requires members to develop and maintain ties with such teams; this process is believed to be complex and stressful (Balkundi *et al.*, 2019; MacDonald and Leary, 2005). As argued above, qualified gatekeepers with highly developed networking skills can largely decrease this stress of accessing knowledge from other teams through creating and maintaining networks with other teams as well as setting knowledge protection regulation on behalf of the entire teams. Consequently, members on R&D teams can coordinate with other teams without expending substantial time and efforts and eventually become more capable of absorbing new external knowledge from external third parties. In this context, qualified gatekeepers can enhance their positive effects on their teams' PAC through facilitating the degree of IC. Thus, we hypothesize:

H7. Team IC mediates the impact of gatekeepers' abilities on PAC.

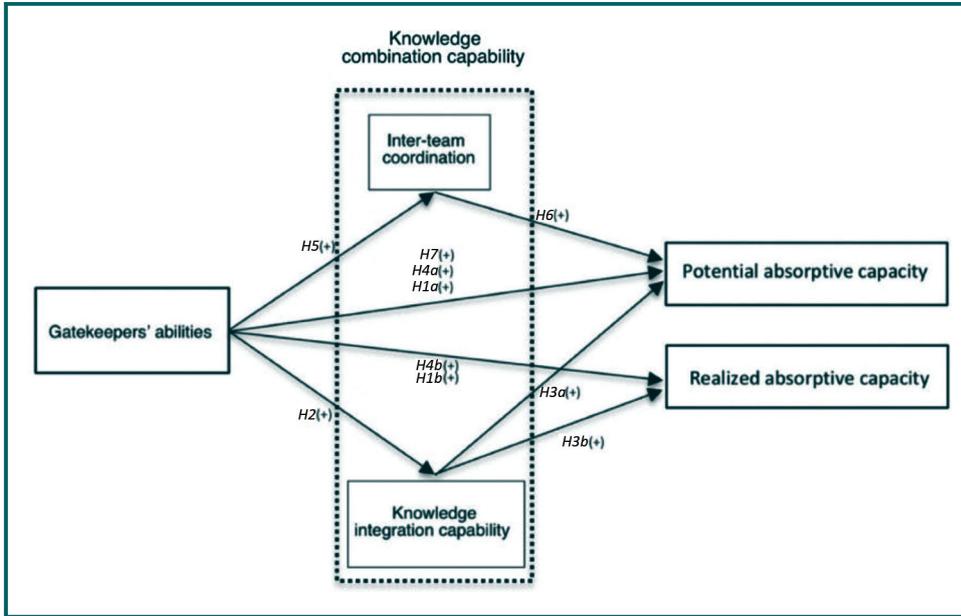
Figure 2 depicts our hypothetical model in this study.

4. Methodology

4.1 Research setting and data collection

This study examined its model in the context of R&D teams because both AC and gatekeeping theories were generated in an R&D context. Two leading Japanese manufacturers (X and Y – both of which operate very well-known R&D labs) were chosen through a purposive sampling technique. Both firms' R&D labs are regarded as among the top 10 in Japan and place great value on open innovation. Thus, the study believed that the R&D teams in these two firms were representative. Considering that companies may be sensitive to this study because of technology privacy issues, the heads of the R&D labs of these two companies were contacted for permission to conduct the survey. After the research was explained, they both agreed to it. Next, voluntary response sampling was used to choose sample teams because all members' questionnaire responses were needed to form an accurate social network. Consequently, 32 teams working in different fields were selected. To avoid biased samples resulting from nonprobability sampling, the researchers then asked the heads and submanagers of the R&D labs whether there are team-level differences in average age, education level, work experience and performance between sample teams and those who did not volunteer to participate. However, we did not ask for specific information about each member to avoid possible privacy issues. Based on their answers, no significant differences were found. In addition, the researchers asked a few

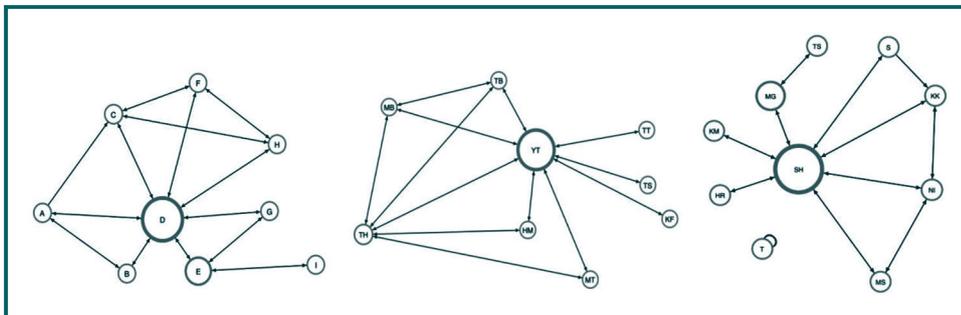
Figure 2 Theoretical framework



R&D professors and practitioners to ensure that the research fields of these 32 teams were representative of industrial R&D in Japan. Thus, this study believed that the sample teams were representative and deemed sufficient for this study.

A short online questionnaire (Appendix 1) modified from the original English version proposed by Whelan *et al.* (2010) was administered from May 2019 to September 2021 to identify individuals who perform gatekeeping roles (including gatekeepers and external and internal communication stars). A total of 378 responses were received for the social network analysis (SNA), resulting in a response rate of 100%. The study used Gephi 0.9.2, a popular SNA software package, to map the social networks of these teams. Furthermore, only reciprocated interaction was incorporated into the sociogram social network mapping works to confirm the validity of our results (Whelan *et al.*, 2010). Some examples of social network maps are shown in Figure 3. We also use Gephi to calculate the betweenness centrality of each member, which can reflect the influence of a specific member on the internal information flow, to grasp each member's internal communication distributions. The area of a circle in Figure 3 reflects the level of each member's betweenness centrality.

Figure 3 Examples of social network map



Then, the researchers adapted the method indicated by [Whelan et al. \(2010\)](#) to calculate each member's external communication distributions. External communication stars were only those ranked in the top 20% of external distributions, while internal communication stars were individuals ranked in the top 20% of internal distributions on their respective teams. Moreover, gatekeepers were individuals who ranked in the top 20% of both the internal and external communication distributions. Eventually, 137 individuals (including 48 internal communication stars, 68 external communication stars and 21 gatekeepers) were identified. The demographic details of the sample teams and individuals are shown in [Table 3](#). Eighty-seven percent of the respondents were male, being consistent with male-dominant R&D lab occupations. In addition, only 4% of the respondents were foreigners. This is understandable because Japanese labs tend to hire Japanese people rather than foreigners to avoid risks such as technology spillover or conflicts resulting from language problems (English is not an official language in most labs). Almost half of the respondents had acquired PhDs and 13% had only bachelor's degrees. This is consistent with the prior indication that demonstrated gatekeepers were individuals who are highly educated and access a deep knowledge base ([Allen and Cohen, 1969](#); [Whelan et al., 2010](#)). Therefore, the researchers believe that our sample represented the actual circumstances of gatekeepers in R&D labs.

Moreover, the results of our SNA were reported to each team between November 2019 and October 2021 and found that the social network maps were representative of the communications. Furthermore, the identified individuals in each team did play vital roles. This result also provided further evidence to support the method of finding gatekeepers using SNA, as suggested by [Whelan et al. \(2010\)](#). Then, all identified individuals were asked to participate in the final online survey conducted from March 2020 to October 2021. Consistent with prior research ([Larson, 2019](#)), confidentiality assurances were added to reduce social desirability bias. Specifically, in the opening questionnaire statement, results were promised to only be reported at an aggregate level to prevent the

Table 3 Sample demographics

Informant information	Frequency	(%)
<i>Team level</i>		
Individuals performing gatekeeping activities		
Only gatekeepers	2	6
Internal and external communication stars but no gatekeepers	16	50
Gatekeepers, internal and external communication stars	14	44
<i>Individual level</i>		
<i>Gender</i>		
Male	119	87
Female	18	13
<i>Age</i>		
26–30	52	38
31–35	40	29
36–40	25	18
41–45	12	9
Above 45	8	6
<i>Nationality</i>		
Japanese	131	96
Non-Japanese	6	4
<i>Education level</i>		
Bachelor	18	13
Masters	52	38
Ph.D. (including courses and dissertation)	67	49

identification of any teams and all individual responses were kept confidential. When the researchers reported the results to each team between March and November 2021, we also checked the social desirability bias by privately asking some members whether they provided socially acceptable answers. Based on their replies, we believe that social desirability bias can be largely excluded from this study. Furthermore, the researchers also compared the earlier questionnaire responses to those submitted later and found no difference. Thus, it is believed that systematic nonresponse bias was not observed in this study. Harman's single factor test was conducted after data collection to assess possible common method bias (Podsakoff *et al.*, 2003). The result shows that the total variance for a single factor is 27.9%, which is less than the threshold of 40%, indicating the absence of common method bias.

4.2 Measures

Respondents ranked all the above variables on a 5-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The original items were translated from English to Japanese. All items are shown in [Appendix 2](#).

To measure gatekeepers' abilities, we created a reflective-formative second-order construct consisting of three reflective first-order factors (knowledge acquisition, knowledge dissemination and networking) based on the indications of Whelan *et al.* (2010). Reviewing 216 paper publications, Hung (2017) used "the proportion of paper references citing foreign authors and the proportion of new references made within 5 years" to measure how well gatekeepers fulfilled their knowledge acquisition function (p. 310). Therefore, the above two items were used to measure knowledge acquisition abilities. According to Whelan *et al.* (2010), knowledge dissemination abilities depend on the ability of gatekeepers to understand, translate and disseminate complex external knowledge, while internal networking roles can be determined by the extent to which gatekeepers enjoy helping others and their networking skills. Accordingly, three items for each of these abilities were created.

This study combined research that divides PAC into acquisition and assimilation (Jansen *et al.*, 2005; Zahra and George, 2002) and research that divides AC into science-push and demand-pull (Murovec and Prodan, 2009) to create a reflective-formative third-order construct of PAC. Specifically, the formative third-order of PAC consists of two formative second-order factors: demand-pull and science-push PAC, to which then contribute reflective first constructs: demand-pull acquisition (DAC), demand-pull assimilation (DAS), science-push acquisition (SAC) and science-push assimilation (SAS). DAC includes four market sources: suppliers, clients or customers, competitors within the same industry and informal contacts with industry friends or trade partners (revised from Murovec and Prodan, 2009). SAC, in contrast, consists of three scientific knowledge sources: fairs and exhibitions, universities or other higher education institutions and government or private nonprofit research institutes (revised using Murovec and Prodan, 2009). Moreover, questions about SAS (two items) and market-related assimilation (MAS, three items) were revised using Jansen *et al.* (2005). RAC was also measured by a reflective-formative second-order construct revised using Jansen *et al.* (2005). Transformation (TRA, seven items) and exploitation (EXP, five items) are reflective first-order factors of RAC.

A KIC measurement scale was created based on the study by Gardner *et al.* (2012). Three out of the ten original items were deleted because their low loading scores resulted in low average variance extracted (AVE) scores. Accordingly, we used four of the original five items proposed by Hoegl *et al.* (2004) to investigate respondents' perceptions of the effectiveness of their teams' coordination with other teams.

4.3 Analytical methods

The data were analyzed using different statistical tools. Instead of using covariance-based structural equation modeling (CB-SEM), which Amos often executes, we choose partial least squares structural equation modeling (PLS-SEM) in this study. The reason is that this study meets the following conditions proposed by [Hair et al. \(2019\)](#) in which PLS-SEM should be used in preference to CB-SEM:

- the object of the study is to explore theoretical extensions of existing theories instead of purely testifying a model combined of established theories;
- the study uses relatively small sample sizes to testify an extremely complex structural model with a lot of constructs and a lot of indicators;
- the model includes more than one reflective-formative higher-order constructs; and
- the study requires latent variable scores for further analyses.

PLS-SEM was executed by the SmartPLS 3 software package ([Ringle et al., 2015](#)), which has also been widely adopted by recent studies in the AC literature ([Ali et al., 2018](#); [García-Villaverde et al., 2018](#)). Although PLS-SEM analyzes how well the structural model fits the data, it cannot ensure the predictive validity of the model ([Shmueli et al., 2016](#)). Therefore, the study also used cross-validation tests with holdout samples suggested by [Cepeda Carrión et al. \(2016\)](#) to check the predictive validity. The results are presented in the next section.

5. Results and analysis

PLS-SEM requires researchers to assess the measurement (outer) model before testing their structural (inner) model.

5.1 Assessment of the measurement model

The reliability and validity of the items were evaluated through tests of reliability, convergent validity and discriminant validity. The results are presented in [Tables 4](#) and [5](#). The Cronbach's alpha (CA) values of all first-order reflective latent variables and composite reliability (CR) values were above the threshold of 0.7. Thus, the reliability of the study's model was acceptable. Standardized loadings of reflective first-order items can reflect individual item reliability and should exceed the threshold of 0.707 ([Carmines and Zeller, 1979](#)). As shown in [Table 4](#), all values of reflective items in our model exceed this threshold, except for three items (KD1, TRA4 and TRA7), which are above 0.62. Items with a factor loading between 0.40 and 0.70 can be retained if their removal does not lead to an increase in CA, AVE and CR values ([Hair et al., 2017](#)). Thus, all three items were retained. The results of the resampling bootstrap method with 5,000 show that all loadings are significant at a level of 0.01, indicating that the indicator reliability is acceptable. All AVE values were above 0.5, showing that the chosen measurement model had acceptable convergent validity ([Fornell and Larcker, 1981](#)).

Furthermore, three approaches to evaluate discriminant validity were used in this study: all indicators' outer loadings on the associated construct are greater than the highest correlation with other constructs; the AVE square root of all constructs was above the highest correlation with other constructs (Fornell-Larcker criterion); and the greatest heterotrait-monotrait value is 0.80, which is below the threshold of 0.85. Thus, all three of these results indicate that discriminant validity is acceptable.

5.2 Testing the structural model

We used five different tests to evaluate the structural model ([Ali et al., 2018](#); [García-Villaverde et al., 2018](#)) including: variance inflation factor (VIF) values, R^2 , Q^2 , path

Table 4 Measurement model

<i>Factors</i>	<i>SL</i>	<i>t-value</i>	<i>VIF</i>	<i>CA</i>	<i>CR</i>	<i>AVE</i>
<i>First-order reflective constructs</i>						
<i>KA</i>				0.81	0.91	0.84
KA1	0.94	6.24	1.88			
KA2	0.90	5.65	1.88			
<i>KD</i>				0.78	0.86	0.67
KD1	0.70	3.70	1.62			
KD2	0.86	7.27	1.67			
KD3	0.89	7.20	1.57			
<i>NET</i>				0.86	0.91	0.78
NET1	0.89	33.36	2.17			
NET2	0.86	24.98	2.087			
NET3	0.90	30.02	2.31			
<i>DAC</i>				0.81	0.87	0.63
DAC1	0.78	14.01	1.72			
DAC2	0.81	17.86	2.06			
DAC3	0.82	25.66	1.73			
DAC4	0.76	15.70	1.87			
<i>DAS</i>				0.79	0.88	0.71
DAS1	0.89	40.56	1.90			
DAS2	0.83	25.31	1.68			
DAS3	0.81	17.28	1.59			
<i>SAC</i>				0.82	0.89	0.74
SAC1	0.87	34.95	1.81			
SAC2	0.85	23.33	2.01			
SAC3	0.85	22.65	1.77			
<i>SAS</i>				0.76	0.89	0.81
SAS1	0.91	45.88	1.60			
SAS2	0.88	28.23	1.60			
<i>TRA</i>				0.84	0.88	0.52
TRA1	0.74	11.68	1.61			
TRA2	0.71	12.77	1.79			
TRA3	0.75	16.70	2.01			
TRA4	0.68	10.41	1.65			
TRA5	0.74	15.16	1.89			
TRA6	0.77	18.71	1.78			
TRA7	0.62	9.33	1.46			
<i>EXP</i>				0.83	0.88	0.59
EXP1	0.83	23.79	2.20			
EXP2	0.73	13.81	1.48			
EXP3	0.81	19.86	2.01			
EXP4	0.76	15.29	1.87			
EXP5	0.71	11.52	1.64			
<i>KIC</i>				0.88	0.91	0.58
KIC1	0.77	16.56	1.961			
KIC2	0.79	18.07	2.176			
KIC3	0.72	13.86	1.617			
KIC4	0.76	14.12	2.006			
KIC5	0.77	17.02	2.204			
KIC6	0.80	20.53	2.202			
KIC7	0.72	14.38	1.617			
<i>IC</i>				0.85	0.90	0.70
IC1	0.85	29.81	2.127			
IC2	0.84	25.02	2.088			
IC3	0.77	15.91	1.582			
IC4	0.89	43.26	2.563			

(continued)

Table 4

Factors	SL	t-value	VIF	CA	CR	AVE
<i>Second-order formative constructs</i>						
Construct			Weight		VIF	
KA->GA			0.35 ^{***}		1.11	
KD->GA			0.52 ^{***}		1.17	
NET->GA			0.53 ^{***}		1.09	
EXP-> RAC			0.51 ^{***}		1.41	
TRA-> RAC			0.63 ^{***}		1.41	
DAC-> Demand-pull PAC			0.64 ^{***}		1.21	
DAS-> Demand-pull PAC			0.55 ^{***}		1.21	
SAC-> Science-push PAC			0.73 ^{***}		1.15	
SAS-> Science-push PAC			0.47 ^{***}		1.15	
<i>Third-order formative constructs</i>						
Demand-pull PAC -> PAC			0.64 ^{***}		1.33	
Science-push PAC -> PAC			0.51 ^{***}		1.33	

Notes: *|t|N = 1.96 at $p = 0.05$ level; **|t|N = 2.58 at $p = 0.01$ level; ***|t|N = 3.29 at $p = 0.001$ level; n.s = nonsignificant; SL = standardized loadings

Table 5 Means, standard deviations, Fornell–Larcker criterion and HTMT

Factors	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1. KA	3.86	1.00	0.92	0.37	0.19	0.15	0.06	0.21	0.31	0.12	0.11	0.08	0.11
2. KD	4.07	0.58	0.25	0.82	0.33	0.17	0.14	0.21	0.16	0.19	0.15	0.07	0.22
3. NET	4.03	0.78	0.15	0.25	0.88	0.30	0.30	0.14	0.20	0.34	0.31	0.36	0.35
4. DAC	3.61	1.03	-0.09	0.12	0.25	0.79	0.51	0.44	0.21	0.54	0.42	0.43	0.58
5. DAS	3.19	0.85	0.03	0.12	0.25	0.41	0.84	0.45	0.64	0.67	0.38	0.64	0.55
6. SAC	3.60	0.97	0.15	0.18	0.10	0.37	0.37	0.86	0.45	0.60	0.38	0.45	0.63
7. SAS	3.58	0.86	0.24	0.11	0.16	0.17	0.50	0.36	0.90	0.52	0.34	0.57	0.52
8. TRA	3.47	0.90	0.08	0.09	0.30	0.47	0.57	0.52	0.43	0.72	0.64	0.80	0.53
9. EXP	3.60	0.89	0.09	0.10	0.27	0.35	0.32	0.32	0.28	0.54	0.77	0.51	0.44
10. KIC	3.59	0.83	0.02	0.01	0.32	0.37	0.54	0.39	0.47	0.70	0.45	0.76	0.53
11. IC	3.67	0.78	0.09	0.21	0.30	0.50	0.46	0.53	0.43	0.46	0.37	0.46	0.84

Note: Fornell–Larcker criterion values are below the diagonal while HTMT values are above the diagonal; HTMT = heterotrait-monotrait ratio of correlations

coefficients and significance levels of path coefficients. All VIF values for all possible sets of predictor constructs were below 1.3, which is far below the maximum threshold of 5. Therefore, collinearity is not a concern in this study.

As shown in Figure 4, the R^2 values of PAC (0.54) and RAC (0.45) meet the minimum acceptable level (Falk and Miller, 1992), demonstrating that that model has in-sample predictive power. Figure 4 also shows that the Q^2 values of PAC (0.53) and RAC (0.44) generated from blindfolding with an omission distance of 7 exceeded zero, supporting the predictive relevance of the chosen model (Hair et al., 2017). Bootstrap analysis with 5,000 resamples was used to test the study's hypotheses of direct effects. The results are presented in Table 6.

Both the bootstrapping method and variance accounted for (VAF) were used to test these mediating effects (Hair et al., 2017). Specifically, the bootstrapping procedure was first used to investigate indirect path significance. As shown in Table 7, all three indirect paths proposed by our hypotheses are significant. The VAF scores of these three specific indirect paths were above 20%, meaning that mediations do exist (Hair et al., 2017). As the direct effects between gatekeeper abilities (GAs) and PAC are not significant, the two knowledge

Figure 4 Mediation model

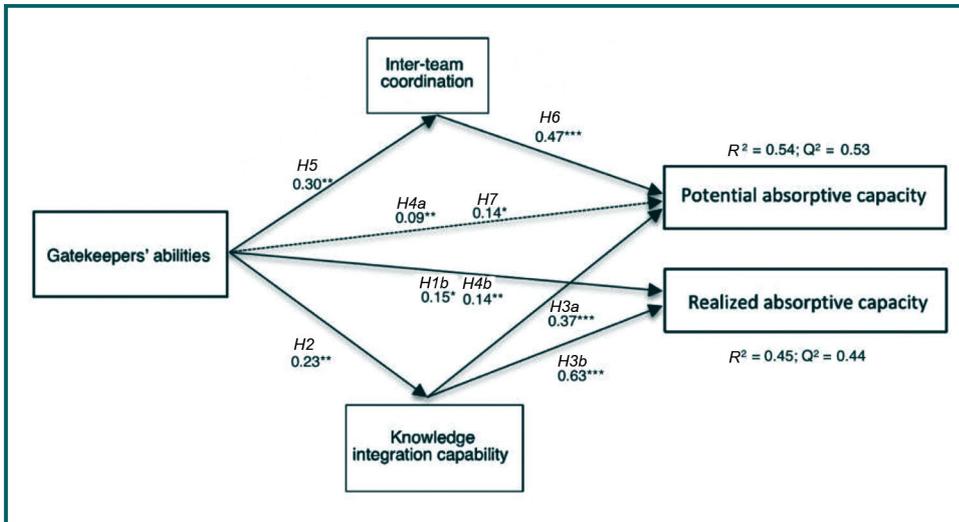


Table 6 Significance of the structural model direct path coefficients

Path	Path coefficient	t-value	p-values	Significance level	95% BCa confidence interval	Conclusion
GA -> PAC	0.05	0.87	0.384	n.s	(-0.07, 0.15)	H1a not supported
GA -> RAC	0.15	2.47	0.014	*	(0.04, 0.29)	H1b supported
GA -> KIC	0.23	2.69	0.007	**	(-0.002, 0.27)	H2 supported
KIC -> PAC	0.37	5.44	0	***	(0.23, 0.49)	H3a supported
KIC -> RAC	0.63	9.00	0	***	(0.46, 0.74)	H3b supported
GA -> IC	0.30	3.23	0.001	**	(0.06, 0.47)	H5 supported
IC -> PAC	0.47	6.36	0	***	(0.32, 0.61)	H6 supported

Notes: *|t|N = 1.96 at $p = 0.05$ level; **|t|N = 2.58 at $p = 0.01$ level; ***|t|N = 3.29 at $p = 0.001$ level; n.s = nonsignificant; BCa = bias corrected confidence interval; GA = gatekeeper abilities

Table 7 Test of mediation by bootstrapping approach and VAF

Effect of	Indirect effect	T statistics	Total effect	VAF (%)	Interpretation	Conclusion
GA -> KIC -> PAC	0.09 [†]	2.31	0.28**	32	Indirect-only (full) mediation	H4a supported
GA -> KIC -> RAC	0.14 [†]	2.44	0.30***	47	Indirect-only (full) mediation	H4b supported
GA -> IC -> PAC	0.14**	2.75	0.28**	50	Indirect-only (full) mediation	H7 supported

combination capabilities in this study fully mediate the relationships between GA and PAC (Hair *et al.*, 2017). The results are shown in Figure 4.

5.3 Assessment of predictive validity

Consistent with prior research (Ali *et al.*, 2018), we used eight-step cross-validation tests with holdout samples suggested by Cepeda Carrión *et al.* (2016) to test the predictive validity of the above mediation model. First, the original data were randomly divided into a training sample ($n = 91$) and a holdout sample ($n = 46$). A training sample was used to estimate the parameters in our model. Each holdout sample was standardized, and their scores were calculated using the weights from the training sample. Then, the researchers standardized the above construct scores and calculated predictive scores of two endogenous constructs, PAC and RAC, through the path coefficients obtained from the

training sample. Finally, the correlation between predictive and construct scores was tested. Results show that the correlations between predictive and construct scores of PAC and RAC are 0.80 and 0.78 ($p < 0.01$), respectively, suggesting that the mediation model had highly predictive validity.

6. Discussion, implication and limitation

6.1 Discussion

Four critical findings of this study will be discussed as follows. First, the results of SNA showed that 87% of gatekeepers had obtained at least a master's degree, providing evidence to the arguments of prior studies that the gatekeeper role tends to be performed by highly educated individuals (Allen and Cohen, 1969; Whelan *et al.*, 2010). In addition, based on the results of SNA, we found only two teams in which gatekeeping activities were centralized. An interview with the corresponding gatekeepers also showed that they all felt extremely stressed and agreed that it would be more effective if other members shared their gatekeeping functions. These findings provide extra evidence to the proposition of Harada (2003) and Whelan *et al.* (2010) that gatekeeping activities in modern R&D organizations should better be undergone a division of labor.

Second, despite an implicit consensus that gatekeepers directly contribute to the acquisition and assimilation (Daghfous, 2004; Schillaci *et al.*, 2013), our results showed that qualified gatekeepers could only indirectly affect team-level PAC. This finding sheds light on the role of individuals in the process of external knowledge absorbing activities. Specifically, in a modern knowledge-based society, in which more diverse knowledge is needed and the gap between the education level of employees has been largely reduced, the external knowledge acquisition and assimilation activities should better be deconcentrated, and each member is likely to dedicate themselves to a range of absorption efforts. This is consistent with the findings that normal organizational individuals play a vital role in the knowledge absorption processes (Distel, 2019; Sjödin *et al.*, 2019; Yao and Chang, 2017), and the innovative activities (Bogers *et al.*, 2018; Enkel *et al.*, 2017; Spithoven *et al.*, 2010). On the other hand, gatekeepers perform a “coach” role of supporting their colleagues' acquisition and assimilation activities. Specifically, they help a colleague access knowledge residing in other colleagues more effectively or simply bring required knowledge to that person from other colleagues, thus contributing to the extension of his/her knowledge base. This extension of an individual prior knowledge base can reduce the likelihood of the mismatch between external knowledge and knowledge base and thus make individuals more capable of absorbing specific external knowledge they were not familiar with.

Third, both the direct and indirect effect of qualified gatekeepers on RAC is supported, which supports the arguments of El Samra (2021) that the role of gatekeepers is likely to be evolving, and they may also play a vital role in the implementation of knowledge. Specifically, gatekeepers can give valuable advice about how to transform and apply a specific new knowledge to their colleagues, thus directly affecting the RAC. This “go-to” or “consultant” character of gatekeepers has already been proposed in some prior studies (Whelan *et al.*, 2010; Whelan *et al.*, 2013). Besides giving the advice directly, gatekeepers can also indirectly promote the efficiency of their colleagues' transformation and exploitation activities through the aforementioned positive effect on their colleagues' knowledge base.

Fourth, our results showed that a R&D team with qualified gatekeepers could have high abilities of knowledge combination, providing evidence to the assumption of Zahra *et al.* (2020) that “knowledge integration processes are better left to specialists” (p. 31). Considering the trade-off between time and effort individuals can devote to external and internal knowledge sourcing (Dahlander *et al.*, 2016; Monteiro and Birkinshaw, 2017), it is

understandable that internal knowledge processing activities should be centralized when external knowledge sourcing is decentralized. The significant positive effects of knowledge combination capabilities on AC were also testified, thereby supporting the findings of [Distel \(2019\)](#) and [Lowik et al. \(2016\)](#) that an organization's internal integration plays a vital role in the process of AC.

6.2 Implications for theory

The researchers believe that three distinct theoretical contributions were made in this study. The first contribution of the study is that we extend gatekeeping theory by investigating the overall role of gatekeepers in modern R&D teams. Some researchers have already realized that the current gatekeeping theory, mainly generated between 1970s and 1990s, were likely to be outdated, and the roles of gatekeepers may be evolving, especially as the world has changed rapidly during the past 30 years. For instance, with the development of internet technologies, individuals can now more easily access external knowledge through a large variety of channels. The original gatekeeping role of introducing new knowledge from outside is now vastly mitigated and some new roles of gatekeepers can be expected ([Kyprianos et al., 2020](#); [Whelan et al., 2010](#)). In addition, the original division of labor in the process of external knowledge absorption is likely to change when inhabiting a modern knowledge-based society where organizations need a wide variety of knowledge and the gap in the educational environment is vastly reduced. Consequently, there is likely to be a corresponding change in the roles and responsibilities of gatekeepers ([El Samra, 2021](#)). Based on the results of this study, we confirmed the change mentioned above and suggest that instead of acting as “superheroes” and introducing external new knowledge from external third parties all by themselves, gatekeepers in modern R&D teams mainly perform a “coach” function and make their colleagues more qualified for external knowledge absorbing and applying. This “coach” role includes helping their colleagues better acquire knowledge reside in the whole company through creating networking ties; bringing required knowledge to a specific colleague from members both within the team and in other teams; giving highly valuable advice to their colleagues for their better transforming and applying a specific new knowledge.

The second contribution is the extension to current AC literature at the micro-level. Although prior research has investigated the effect of the variations in the level of AC on multifaceted performance outcomes, an understanding of how organizations develop greater or lesser AC remains neglected ([Bouguerra et al., 2021](#); [Martinkenaite and Breunig, 2016](#)). One reason for this is the limited understanding of how different components of AC arise from the actions and interactions of lower-level actors, such as individuals ([Lane et al., 2006](#); [Volberda et al., 2010](#)). Although recent researchers have started focusing on this new interest and have testified some vital individual characters ([Table 2](#)), current studies have not yet realized its full potential. Moreover, further investigations related to the micro-processes formed by individuals' roles and activities are also believed to be essential ([Badir et al., 2020](#); [Ter Wal et al., 2017](#)). By investigating the gatekeepers' roles in AC process, this study has responded to this research call and opened the “black box” of individual activities that constitute an organization's AC.

Finally, we contribute to the KM literature by investigating knowledge combinations at the micro-level. As a central concept in the KM process, knowledge combination has attracted considerable research attention ([Balle et al., 2020](#); [Kogut and Zander, 1992](#)). Nevertheless, little is known about the “consequences of knowledge integration and its processes for the individual members of an organization” ([Zahra et al., 2020](#), p. 14). This study provides interesting insights into this limitation. Specifically, our results suggest that knowledge-integrating activities are highly likely to be centralized in R&D teams. Furthermore, our results show that teams with a high level of knowledge integrating capability tend to acquire

more external knowledge. Consequently, these team members will have a greater chance of expanding their personal knowledge base to accelerate their personal growth.

6.3 Implications for managerial practice

This study has some practical implications for managerial strategy. Specifically, it was widely accepted that organizations should simultaneously pursue both exploration and exploitation innovation (Chen and Kannan-Narasimhan, 2015). Facilitating PAC and RAC and supporting the individuals' activities in this process, based on prior research, are critical for achieving the ambidextrous organizations (Enkel *et al.*, 2017; Limaj and Bernroider, 2019; Swart *et al.*, 2019). Our results showed that both gatekeepers and combination capabilities were critical factors supporting the AC-related activities of individuals. We thus suggest managers achieve their organizations' ambidexterity from these two dimensions.

The managerial contributions have also been made. Organizations increasingly count on their R&D staff for the introduction of diverse new knowledge from external third parties. There is no doubt that employees in R&D labs face a new set of challenges and have a lot of pressure on employees in R&D labs. Organizations, therefore, need to prepare a new supporting system to encourage and enable their employees to perform these roles successfully. This study offers some insights into these organizations. Specifically, individuals typically struggle to absorb and apply external new knowledge from disciplines unfamiliar with. To overcome this mismatch resulting from the restriction on individual knowledge base, managers should pay attention to find individuals who perform gatekeeping activities using the SNA method in this study and develop specific supporting and reward systems to promote these individuals' abilities and motivation to perform knowledge-combining activities. In addition, developing formal communication systems and mechanisms, such as regular progress meetings inside teams and public staff meetings that teams in different departments attend, is also recommended.

6.4 Limitation and further research

Despite the contributions of this study, the limitations should also be reported. First, the data used to test our hypothetical model came from 32 R&D teams at major R&D institutions. This may have limited the general validity of the findings of this study, such that our model may not apply to R&D teams in small- or medium-sized R&D laboratories or nonlaboratory contexts. Further research thus may test the proposed theoretical model in more different contexts.

Second, despite the considerable effort made to ensure that the data factually represent respondents' perceptions of variables in our model, the results generated in an individual-level analysis may differ from those generated in a team-level analysis. It may be fruitful for future research to conduct multilevel analyses, using a method that takes both the organizational context and individual respondents into consideration to overcome this limitation.

Third, causal complexity, including the problem of equifinality, conjunctural causation and causal asymmetry, may result from a quantitative research design and limit our ability to get more detail about the complex mechanisms between the constructs under study. Considering the intricacies of the concepts and their relationships in this study, qualitative research designs, such as qualitative comparative analysis (QCA) would be useful.

Fourth, although this study revealed the vital role of gatekeepers in the process of AC, we did not mention how to support them. Gatekeepers normally play a "buffer" role and thus experience typically perceived uncertainty. In addition, developing networks and communicating knowledge to others necessitate a lot of time and effort. Consequently,

gatekeeping activities can be exhausted and thus require adequate organizational support. Future studies may investigate antecedents of the efficiency of gatekeeping activities.

7. Conclusions

The motivation for this study was to explore the roles of individuals in the actual process of team AC by investigating the role of qualified gatekeepers. Based on the original gatekeeping theory generated between 1970s and 1990s, qualified gatekeepers mainly search valuable external knowledge and pass it to normal members in a form that they can understand. Normal members, on the other hand, combine the external knowledge from gatekeepers into their own individuals' knowledge base and apply it to final use. Based on this perspective, it is reasonable to assume that qualified gatekeepers only have direct contribution on PAC. Some recent research, nonetheless, emphasized a possibility that the role of gatekeepers may have already changed. Specifically, normal members are also likely to perform the role of external knowledge acquisition and assimilation. In this situation, qualified gatekeepers help their colleagues for the effective external knowledge absorption, as well as pay attention on how to combine and apply external knowledge absorbed from their colleagues. In this context, another assumption that qualified gatekeepers directly contribute to their teams' RAC but has only indirectly positive effect on their teams' PAC. To reveal the role of qualified gatekeepers in modern organizations, this study included both aforementioned two assumptions into our hypothetical model and testified it through PLS-SEM.

Based on the results reported and discussed above, we found that the abilities of gatekeepers did not have direct effect on PAC but indirectly contributed to it through the mediating role of KIC and IC. This finding indicated that instead of absorbing external knowledge themselves, qualified gatekeepers mainly focus on helping colleagues with their external knowledge absorption activities through reducing the difficulty of accessing background knowledge required for the external knowledge absorption from other colleagues within the whole company. In addition, we also found that the abilities of gatekeepers directly facilitate the level of their teams' RAC. This finding indicated that qualified gatekeepers also act as "commander" and perform a role of deciding how to combine and apply external knowledge absorbed from other colleagues to generate better prototypes. Finally, the direct impact of gatekeepers' abilities to knowledge combination capabilities was found significant, indicating that knowledge combination activities in modern R&D teams are centralized to qualified gatekeepers.

Through revealing the roles of qualified gatekeepers in the process of AC, this study makes several theoretical contributions. For instance, not only does this study open the "black box" of AC and deepen the understanding of how this construct can be deconstructed among individuals, but it also contributes to the updating of original gatekeeping theory and linked it with the theories in the field of AC and KM. Finally, a contribution to the literature on KM is also made through recognizing and empirically testifying the antecedents and outcomes of internal knowledge combination. Two major practical contributions are also made by this study. Based on the findings of this study, we suggest that managers should:

- facilitate their teams' PAC and RAC to achieve their organizations' ambidexterity;
- find gatekeepers through SNA method and develop specific new human resources management to promote their abilities; and
- develop formal and informal communication systems within the team and with other teams.

Some limitations, however, do exist. For instance, data from R&D teams in small- or medium-sized R&D laboratories or nonlaboratory contexts should also be used to test our hypothetical model to guarantee the general validity of the findings in this study.

Furthermore, some extra methods, such as, multilevel analyses and QCA, should be used to ensure the validity and reliability of aforementioned findings. Finally, the specific methods of supporting gatekeepers in performing their new roles were also not investigated in this study. Despite these limitations, we believe the findings in this study do have a certain significance in the KM studies, as well as R&D management in practice. The authors also hope that future studies will be developed to investigate remaining problems.

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Figure A1 SNA questionnaire

Introduction

Please answer all 4 questions. The questionnaire will only take 2-3 minutes to complete.

1. Your name?

2. Please identify which work colleagues you discuss technical issues with at least once a week?
 [Please check all that apply]

<input type="checkbox"/> AA	<input type="checkbox"/> EE	<input type="checkbox"/> II
<input type="checkbox"/> BB	<input type="checkbox"/> FF	<input type="checkbox"/> JJ
<input type="checkbox"/> CC	<input type="checkbox"/> GG	<input type="checkbox"/> KK
<input type="checkbox"/> DD	<input type="checkbox"/> HH	<input type="checkbox"/> LL

3. How often do you use the following information sources in your everyday work?

	More seldom	Once a month	Once every two weeks	Once a week	Once every two day	Once a day	Several times a day
Colleagues on other teams	<input type="radio"/>						
Contacts with people that you know personally outside your company (including face-to-face, phone, and email contacts).	<input type="radio"/>						
Academic publications	<input type="radio"/>						
Internet other than accessing journal papers (i.e. website, discussion forums, wikis, blogs)	<input type="radio"/>						

Appendix 2. Questionnaire items

Questionnaire items (five-point Likert scale: 1 “strongly disagree”; 5 “strongly agree”)

Gatekeeper functionalities (GA)

Knowledge acquisition (KA)

- I often read paper references citing foreign authors to acquire new knowledge.
- I often read new references made within 5 years to acquire new knowledge.

Knowledge dissemination (KD)

- I can find links between newly acquired knowledge (including technical and market) and existing knowledge.
- I make an effort to share newly acquired knowledge (including technical and market) with other team members.
- When I explain external new knowledge (including technical and market) to team members, they can easily and correctly understand that knowledge.

Networking (NET)

- I provide technical cooperation and clerical support to troubled team members.
- I believe it is important for members in this team to exchange opinions with each other.
- I take action to facilitate communication between members on our team.

PAC

Market-related acquisition (MAC)

- We have frequent interaction with suppliers of equipment, materials, dimensions or software to acquire new information.
- We periodically organize special meetings with clients or customers to acquire new information.
- We collect new information through talking with friends working at competitors.
- We hardly collect information through informal contacts with industry friends or trade partners. (Reverse-coded)

Market-related assimilation (MAS)

- We quickly analyze and interpret changing market demands.
- New opportunities to serve our clients are quickly understood.
- We are slow to recognize shifts in our market (e.g., competition, regulation, demography). (Reverse-coded)

Scientific acquisition (SAC)

- Our team has frequent interaction with fairs and exhibitions to acquire new information.
- We have frequent interaction with government or private nonprofit research institutes to acquire new information.
- We regularly approach third parties, such as universities or other higher education institutions, to acquire information.

Scientific assimilation (SAS)

- We quickly analyze and interpret new information about science and technology.
- We are slow to recognize shifts of technology. (Reverse-coded)

RAC

Transformation (TRA)

- We regularly consider the consequences of changing market demands in terms of new products and services.
- We record and store newly acquired knowledge for future reference.
- We quickly recognize the usefulness of new external knowledge to existing knowledge.
- We hardly share practical experiences with each other. (Reverse-coded)
- We periodically meet to discuss consequences of market trends and new product development.
- We constantly consider how to better exploit knowledge.
- We have a common language regarding our products and services.

Exploitation (EXP)

- We clearly know how activities within our team should be performed.
- Client complaints fall on deaf ears in our team. (Reverse-coded)
- We have a clear division of roles and responsibilities in our team.

- We have difficulty implementing new products and services. (Reverse-coded)
- We can grasp the opportunities for our team from new external knowledge.

Knowledge integration capabilities (KIC)

- Communications within our team were timely.
- Communications within our team were inconsiderate. (Reverse-coded)
- Communications within our team were right amount.
- Communications within our team were concise.
- Communications within our team were objective.
- Communications within our team were clear.
- Communications within our team were fostering teamwork.

Interteam coordination (IC)

- Connected processes and activities were well coordinated with other teams.
- We have no problem in coordinating with other teams.
- Conflicts with other teams were settled quickly.
- Discussions with other teams were conducted constructively.

About the authors

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