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Study on the Role of Innovation Intermediaries in Open Innovation: From the Perspective of Resource Dependence Theory and Core Competency Theory

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Abstract Open innovation refers to companies overcoming the limitations of existing resources—such as knowledge, technology, R&D, and innovation capabilities—in a rapidly changing and highly competitive environment by utilizing external resource exchanges and knowledge mediation, alongside their internal capabilities. Innovation intermediaries involved in open innovation primarily facilitate collaboration, connect innovation entities, and provide stakeholder services. To analyze the role of innovation intermediaries from the perspectives of resource dependence theory and core competency theory, this study conducted an in-depth analysis of open innovation cases between a large company L and startup E and between a large company H and startup M. The results of the study show that, first, innovation intermediaries resolve resource imbalances between companies and promote open innovation. Second, innovation intermediaries help companies strengthen their core competencies to secure a competitive advantage. Additionally, as demonstrated through insights from the two open innovation cases examined in this paper, it was confirmed that innovation intermediaries must make efforts to connect startups with investors or provide follow-up funding even after open innovation. The significance of this study lies in confirming the critical role of innovation intermediaries in the open innovation process and highlighting the continued need for financial support to startups after open innovation.

Keywords Open Innovation, Innovation Intermediary, Resource Dependence Theory, Core Competency Theory

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I. Introduction

According to Chesbrough (2003), open innovation refers to technological innovation that actively leverages internal capabilities and external ideas or technologies within the overall innovation process to enhance performance. Open innovation provides breakthrough solutions to complex problems involving multiple actors with shared interests. In particular, large companies, which are increasingly recognizing the need to build open innovation ecosystems, can discover new business opportunities through open innovation by collaborating with startups and external R&D efforts (Do & Cho, 2017).

For open innovation to succeed, innovation intermediaries must play a complementary role by facilitating collaboration with external stakeholders, which startups require, and by connecting startups with large companies, which large companies seek. Innovation intermediaries (Howells, 2006; Lopez-Vega & Vanhaverbeke, 2009) perform functions such as fostering collaboration among innovation actors, linking stakeholders, and providing support services.

Startups often lack the resources, capabilities, and experience needed to independently develop and commercialize products (Zheng et al., 2022). Collaborating with external firms through open innovation helps startups enhance product innovation (Shu et al., 2005; Noh et al., 2017). Moreover, it is challenging for startups to achieve sustainable competitive advantages in the market solely through their own R&D (Jeong & Kim, 2017). In such cases, startups can gain a competitive edge through open innovation (Shu et al., 2005; Hallen et al., 2014; Leitão et al., 2022). Additionally, innovation intermediaries play a critical role in the open innovation process by reducing external search costs, thereby improving the capability and speed of firms' innovation activities (Lin et al., 2016). Startups benefit from their alliances with innovation intermediaries, as these intermediaries facilitate product innovation by minimizing search costs (Zhang & Li, 2010).

The complementary role of innovation intermediaries between large companies and startups can be explained through resource dependence theory and core competency theory. Resource dependence theory highlights the need for both large companies and startups to acquire the resources necessary to navigate environmental uncertainty (Pfeffer & Salancik, 1978), as neither can operate in isolation (Scott, 1981). From this perspective, innovation intermediaries balance the interests of large companies and startups in the open innovation process (Klerkx & Leeuwis, 2008), effectively allocating resources between the two. Core competency theory (Hamel & Prahalad, 1990) emphasizes the importance of core competencies in enhancing a firm's competitive advantage. In the context of open innovation, innovation intermediaries enhance core competencies for both large companies and startups

by fostering customer value creation, competitive differentiation, scalability, and resistance to imitation.

Most of the existing open innovation literature focuses on collaborations between large companies and startups (Park et al., 2010; Kwon et al., 2013; Kim & Kim, 2017). Recently, innovation intermediaries have emerged as key players in facilitating practical open innovation processes (Arnold et al., 2010; Tran et al., 2011; Littlewood & Kiyumbu, 2018). This case study demonstrates that innovation intermediaries not only provide a platform for collaboration between large companies and startups but also drive successful open innovation. By examining how innovation intermediaries complement scarce resources and enhance core competencies, this study identifies key influencing factors and presents a theory-based analysis of successful open innovation.

II. Theoretical Backgrounds

1. Open Innovation and Innovation Intermediaries

Innovation refers to the implementation of significantly improved products, processes, new marketing methods, or new organizational methods in business practices, workplace organization, or external relationships (OECD & Eurostat, 2005). Innovation requires a constant flow of new knowledge from outside the organization (Fey & Birkinshaw, 2005), and open innovation is one way to achieve this. Open innovation has been proposed as a means for companies to overcome the limitations of existing resources, such as knowledge, technology, R&D, and innovation capabilities, in a rapidly changing and highly competitive environment. It allows companies to utilize resource exchange and knowledge mediation with external sources while leveraging internal capabilities (Chesbrough, 2003). Open innovation refers to a methodology that enables companies to maximize value-added creation by incorporating external processes, such as research activities, technology development, and commercialization, or by transferring internal technologies to the market. This approach enhances the performance and success of technological innovation while reducing costs (Chesbrough, 2003).

The definition of innovation intermediaries has long been debated, and the term has often been used interchangeably with words like “agents” and “brokers.” Watkins and Horley (1986) referred to innovation intermediaries as “intermediaries” and defined them as organizations that support technology transfer to SMEs. Millar and Choi (2003) described them as “knowledge intermediaries,” defining them as organizations that facilitate the measurement of the intangible value of knowledge received by recipients. Scholars who

referred to innovation intermediaries as "brokers" include Aldrich and von Glinow (1992), who defined them as entities that facilitate the diffusion of new ideas from outside the system into the social system. Bendis et al. (2008) also used the term "brokers" to describe these intermediaries. According to Howells (2006), innovation intermediaries are organizations or institutions that act as agents or brokers in the innovation process between two or more parties.

The role of innovation intermediaries is particularly critical in open innovation processes. Seaton and Cordey-Hayes (1993) emphasized the role of intermediaries in technology exploitation. Bessant and Rush (1995) highlighted the role of independent consultants as bridges in the innovation process. Guston (1999) stressed the role of boundary organizations in technology transfer and the co-production of technology. Similarly, Callon (1994) identified innovation intermediaries as agents of change within scientific networks and local collectives.

Table 1. Role of Innovation Intermediaries

Researchers	Innovation intermediary terminology	Roles
Watkins and Horley (1986)	Intermediaries	Emphasize the role of intermediaries to support technology transfer to SMEs
Aldrich and von Glinow(1992)	Brokers	Emphasize the role of intermediaries to spread new ideas from outside the system into the social system.
Seaton and Cordey-Hayes (1993)	Intermediaries	Emphasize the role of intermediaries in leveraging technology
Callon (1994)	Intermediaries	Emphasize the role of intermediaries in influencing change within scientific networks and local populations
Bessant and Rush (1995)	Consultants as bridge builders	Emphasize the role of independent consultants as a bridge in the transformation process
Shohert and Prevezer(1996)	Intermediaries	Highlighting the role of public and private organizations as agents to transfer technology between hosts and users
Hargadon(1998)	Knowledge brokers	Emphasize the role of intermediaries to help innovate by combining existing technologies in new ways
Howells(1999b)	Innovation intermediaries	Emphasize the active role certain types of service companies play as intermediaries within the innovation system
Provan and Human (1999)	Technology brokers	Emphasize the role of intermediaries to fill information and knowledge gaps in industry networks
Hargadon and Sutton (1997)	Technology brokering	Highlight the role of technology intermediaries, where organizations regularly create new products by connecting existing solutions from other sectors or technologies.
Wolpert (2002)	Knowledge brokering	Emphasize the role of intermediaries to facilitate the exchange of information about innovation between companies

Lopez-Vega and Vanhaverbeke (2009) analyzed the types of innovation intermediaries along two basic dimensions. The first dimension categorizes innovation intermediaries' facilitation pathways into internal and external sources of ideas. Some innovation intermediaries rely on the internal expertise of consultants to propose new solutions (Howells, 2006; Hargadon, 2002), while others draw on external sources of ideas to address innovation problems (Verona et al., 2006; Huston & Sakkab, 2006). The second dimension differentiates between service provision and infrastructure provision in terms of value creation.

Along these two dimensions, innovation intermediaries can be categorized into four types. First, innovation consultants provide innovation "services" by relying on internal sources of knowledge to solve specific innovation problems or requests. They contribute to problem-solving by providing information about market trends or visualizing particular processes. Second, innovation traders sift through the vast number of ideas and innovations originating from the external environment via platforms like Innovation Solvers. They offer these ideas to companies to uncover potential science- and business-driven solutions. Third, innovation incubators provide infrastructure that facilitates the internal exchange of ideas and knowledge among companies aiming to conduct scientific, technological, or business activities. Finally, innovation mediators provide infrastructure to facilitate the integration of external ideas and knowledge—sourced from users, entrepreneurs, and R&D organizations—into the operations of established companies pursuing scientific, technological, or business opportunities.

The need for innovation intermediaries to facilitate open innovation between startups and large companies arises from specific challenges. Building relationships with established organizations and supporting actors is crucial for startups but often proves difficult (Moritz et al., 2021; Noordhoff et al., 2011). Startups, with their limited core resources and lack of established networks, inevitably face difficulties in their early growth stages (Hyytinen et al., 2015). This lack of experience and resources hampers their ability to access innovation networks (Bonner & Walker, 2004; Konig et al., 2015`; Ziakis et al., 2022). Consequently, actors such as innovation intermediaries play a vital role in coordinating interactions between startups and supportive entities (Ziakis et al., 2022; Russo et al., 2019; van Lente et al., 2020; Schepis et al., 2021).

Innovation intermediaries are pivotal in enhancing the innovativeness of startup products (Clayton et al., 2018). They serve as a critical link between startups and the resources necessary for success (Schepis, 2021; Cirella & Murphy, 2022). These intermediaries offer a variety of services to support startups in developing and commercializing innovative products. These services include networking, resource mobilization, investment connections, mediation and mentoring, and market validation (Leitão et al., 2022). Such support helps startups overcome hurdles and successfully bring their products to market (Ding

& Ding, 2022; Cohen, 2013). Notably, the network composition facilitated by innovation intermediaries connects startups with complementary players in the industry, including customers, suppliers, partners, investors, and other relevant stakeholders (Battistella et al., 2018; McAdam & Marlow, 2008; Garengo, 2019; Eveleens et al., 2017; Stam et al., 2014).

2. Resource Dependence Theory

Companies must respond to rapidly changing markets and introduce new products through technological innovation (Gatignon et al., 2002). In this process, companies must seek external resources if they do not possess them internally (Veugelers & Cassiman, 1999) and strive to acquire the necessary resources from the environment. Resource dependence theory, which originated from Emerson's (1962) exchange theory and Blau's (1964) power exchange theory, examines organizations and their relationships in terms of resource exchange.

Pfeffer and Salancik(1978) are the leading proponents of resource dependence theory, emphasizing that organizations must acquire the necessary resources to overcome environmental uncertainty. Fundamentally, resource dependence theory asserts that no organization can be entirely self-sufficient (Scott, 1981). Therefore, organizations must rely on resources from external parties for their survival and growth (Heide, 1994) and develop strategies that account for their dependence on others to ensure continued development (Ulrich & Barney, 1984). In such circumstances, open innovation becomes essential, whether for large companies or startups.

Pfeffer and Salancik's resource dependence theory categorizes the structural characteristics of the environment into three aspects: concentration, scarcity, and interconnectedness. First, concentration refers to the degree to which an organization's resources are distributed within the environment. The higher the concentration of resources, the more dependent a company is on a specific organization, necessitating efforts to minimize this dependence. Scarcity pertains to the abundance of resources, with more abundant resources allowing organizations to acquire a greater variety of them. Interconnectedness describes the closeness of relationships between organizations; higher interconnectedness increases the importance of organizational cooperation. In particular, under the open systems perspective outlined by resource dependence theory, organizations are not self-sufficient entities but are constrained by their external environment. They are interdependent with external organizations that possess the critical resources necessary for their survival (Cho et al., 2018). Another significant consideration in resource dependence theory is environmental uncertainty, defined as the inability to predict future events and situations (Pfeffer & Salancik,

2003). Technical uncertainty in a company's products refers to unpredictable aspects of product changes, customer requirements, and the firm's ability to anticipate future developments (Fink et al., 2006). Pfeffer (1972) notes that strategic alliances tend to occur more frequently in industries characterized by high levels of dependence and uncertainty.

The literature shows that while large companies possess extensive resources, such as capital, technology, and human talent, it is challenging for them to acquire all necessary resources independently. Conversely, startups often have resources that large companies lack, such as innovative ideas, technology, and market insights. In this context, innovation intermediaries help reduce the exploration costs associated with open innovation between large companies and startups (Zhang & Li, 2010). From a resource dependence theory perspective, innovation intermediaries enable large companies and startups to access the external resources they need from one another through facilitation. Furthermore, since startups heavily rely on partnerships with external firms to enhance their competitiveness (Baum et al., 2000), open innovation appears to be a suitable growth strategy. However, trust issues between large companies and startups in the open innovation process and the challenge of balancing their respective interests remain significant hurdles. Innovation intermediaries play a critical role in fostering trust between these entities (Lee et al., 2010) and balancing their interests (Klerkx & Leeuwis, 2008), ensuring that resources are appropriately allocated between large companies and startups.

3. Core Competency Theory

Different scholars have varying perspectives on what constitutes a firm's core competencies. Grant (1991) and Mahoney (1995) classified six types of core competencies as financial resources, material resources, human resources, technological resources, reputational resources, and organizational resources, while Hill and Jones (1992) identified financial capital, material capital, human capital, and organizational capital as the key factors. Similarly, Son and Kim (2007) considered service production management, marketing management, product development, human resource management, finance and accounting management, and organizational management as elements of core competencies. Ortega (2010) categorized core competencies as operational, marketing, and technical competencies, whereas Yang (2012) identified technical, marketing, and structural competencies as the main elements. By examining prior studies on core competency theory, the common elements among the competencies required by firms can be summarized as technological innovation competence, marketing competence, and organizational capital competence.

Technological innovation capability refers to the ability to integrate the processes of developing new technologies, producing products, and creating markets (Damanpour & Evan, 1984). Nam et al. (2022) define it as the capability to achieve technological innovation. Product development enabled by this capability has a positive impact on a firm's sustained competitive advantage (Evangelista & Vezzani, 2010). Various scholars have proposed different elements of technological innovation capabilities. For instance, Yoon (2003) identified them as technological innovation capabilities, technology commercialization capabilities, technology convergence capabilities, and technology intensity, while Sulistyo (2016) included R&D capabilities, technology promotion capabilities, marketing skills, and organizational management capabilities. These capabilities can be enhanced not only through internal innovation but also by absorbing external technology into the company, which helps improve management performance (Smith & Grimm, 1987). Zahra and George (2002) emphasized that technology development personnel should have the ability to introduce and utilize new technologies from outside the company and actively promote technology cooperation with external firms.

Marketing capability is a crucial competence for a firm, representing the process of satisfying customer demand by adding value to the firm's products and services and appropriately utilizing the firm's total knowledge and technological resources to meet market needs (Day, 1994). Vorhies and Yarbrough (1998) viewed marketing capabilities as intangible resources created by marketers in the process of transforming inputs into outputs, while Makadok (2001) defined them as the ability of a firm to deploy or adapt its resources to improve productivity or strategically achieve its goals. Firms with strong marketing capabilities can differentiate themselves through effective branding and improve profitability (Kotabe et al., 2002). However, unlike large firms, early-stage startups with limited internal resources need to maximize their marketing capabilities while efficiently utilizing their existing resources to achieve growth and profitability (Park & Hwang, 2016). Kim and Shin (2013) demonstrated that marketing capabilities positively influence marketing performance in a study of 228 SMEs in Seoul and Gyeonggi Province.

Organizational capital is the ability of a firm to combine human and physical resources to create new products or services that address the needs of consumers, which vary according to changes in the market environment (Prescott & Visscher, 1980). Chung (2016) defined organizational capital as resources created at the organizational level, including a firm's processes, information technology, and corporate strategy. Strong organizational capital enables a firm to create a favorable environment that allows employees to maximize their potential (Amiri et al., 2010). Organizational capital also facilitates smoother task performance by employees within the firm (Bhartesh & Bandyopadhyay, 2005; Li & Lu, 2018).

III. Research Design

1. Research Model

In this study, the role of innovation intermediaries is modeled using the perspectives of resource dependence theory and core competency theory, focusing on the cases of open innovation involving Company L and Startup E, as well as Company H and Startup M. In the proposed research model, since Company L and Startup E, and Company H and Startup M do not independently secure all the resources they need, innovation intermediaries assist them in effectively distributing necessary resources, as framed by resource dependence theory. From the perspective of core competency theory, each innovation intermediary helps Company L and Startup E, and Company H and Startup M, maximize their core competencies in the process of promoting open innovation.

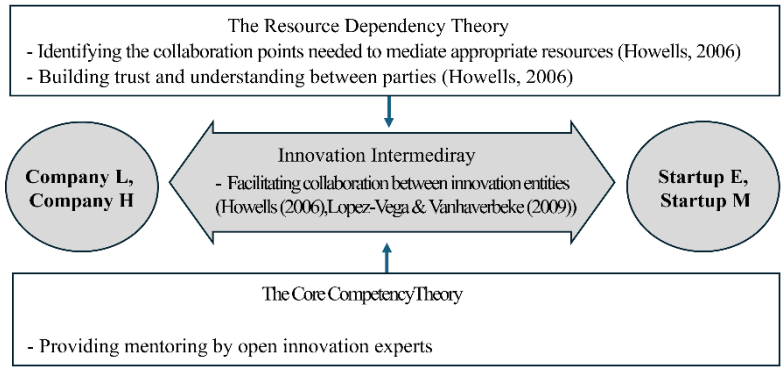

Figure 1. Open Innovation Research Model between Large Companies and Startups by Innovation Intermediaries

2. Research Subjects

(1) Company L, Startup E and Innovation Intermediary S

Company L is a large corporation that generates 60% of its total sales from its H&A and H&E business headquarters. It is heavily reliant on B2C sales, making its performance highly sensitive to economic cycles. To diversify its portfolio, the BS business headquarters, once on the verge of being phased out, was reorganized to focus on revitalizing B2B transactions. It has since become a core division, developing digital X-ray detectors for medical devices based on display technology in the IT/robotics sector. As part of this strategy, Company L participated in the open innovation program organized by Innovation

Intermediary S to collaborate with a startup. This collaboration aimed to launch a new B2B business selling diagnostic devices, such as medical monitors and digital X-rays, by leveraging its flagship product, a display, for applications in the medical field.

Startup E is a deep-tech startup headquartered in Suwon, Gyeonggi-do. Founded in 2019, the company is led by a CEO with a background in nanotechnology research. Startup E specializes in manufacturing CNT X-ray tubes and CNT generators and holds patents for technologies such as high-performance carbon nanotube synthesis equipment, high-performance CNT digital X-ray devices, high-power digital CNT X-ray generators, high-performance CNT electron emission source manufacturing technology, and more. Startup E aims to accelerate its business by developing and manufacturing various next-generation field emission X-ray tubes based on the exceptional field emission properties of carbon nanotubes. The company aspires to become a specialized manufacturer of applications such as X-ray diagnostic medical devices, electrostatic dischargers, and sterilizers. After successfully developing the world's first high-performance digital CNT X-ray device and generator capable of operating at 150kV or higher, Startup E joined the open innovation program organized by Innovation Intermediary S to identify diverse sales channels and secure investment opportunities.

Innovation Intermediary S is a subsidiary of S Financial Group, established to nurture and invest in innovative technology startups, helping them grow into global unicorns. The purpose of its Open Innovation Program is to foster collaboration between startups and large companies or mid-sized companies. The program provides startups with opportunities to expand their business and access vital resources while enabling large and mid-sized companies to enhance their market adaptability and growth through innovative technologies and ideas.

Since its inception in the first period in 2020, the program has completed seven periods by 2023, involving 29 demanding companies, 179 participating startups, and 39 proof of concept (PoC) and business linkage agreements. According to Lopez-Vega and Vanhaverbek's (2010) framework, Innovation Intermediary S fulfills the roles of both an innovation consultant and an innovation incubator. Specifically, as an innovation consultant, its open innovation experts from large companies provide business services to both demanding companies and startups throughout the open innovation process. As an innovation incubator, it provides physical spaces for business interaction and collaboration between the parties.

(2) Company H, Startup M and Innovation Intermediary Z

Company H, a global automobile manufacturing conglomerate, operates its own dealerships and showrooms, with dealers interacting with and serving customers during business hours. Company H has launched a flagship showroom on Songpa-daero, which features an unmanned "nighttime no-holds-

barred showroom" that operates after business hours. While the company can collect data on customer preferences through its dealers during regular hours, it lacks comparable data for after-hours activity. To bridge this gap, Company H sought to compare and analyze data from business and non-business hours to develop an effective sales strategy. To achieve this goal, Company H participated in an open innovation program organized by Innovation Intermediary Z.

Startup M is a deep-tech startup that offers a subscription-based service for video-based visitor data analysis solutions. Leveraging artificial intelligence technology, Startup M analyzes CCTV footage to provide actionable insights to its clients. Its offerings include "total visit analysis data" and "total store data" segmented by gender and age groups, "zone data" to identify products and shelves that attract customer attention, and "movement data" to quantify and map customer movements within stores. These data points support data-driven marketing and offline performance marketing efforts. Notably, Startup M's technology can accurately recognize customers even in challenging scenarios, such as when customers are partially obscured behind a car or wearing a hat. Recognizing that its technology could meet Company H's need to quantify the in-store customer experience in offline settings, Startup M was selected to participate in the Open Innovation Program organized by Innovation Intermediary Z.

Innovation Intermediary Z manages an open innovation program in collaboration with Company H. Each program lasts six months and has been conducted 12 times to date. Participants include 11 subsidiaries of Company H and 150 on-site teams. The program has also engaged 177 startups, leading to 128 collaboration projects and equity investments in 94 startups. The purpose of Innovation Intermediary Z's Open Innovation Program is to identify innovative startups with solutions that align with current projects and connect them with Company H's internal field teams.

3. Deep Interview Methodology

During the research design phase, a structured literature review was conducted to examine the overarching theories and emerging concepts relevant to this study, including open innovation, innovation intermediaries, resource dependence theory, and core competency theory. This review was aimed at enhancing the reliability of the subsequent research findings (Beverland & Lindgreen, 2010). Given the focus on open innovation between large companies and startups facilitated by innovation intermediaries, the study was further enriched by identifying and analyzing research on the functions, types, and roles of "innovation intermediaries." Primary data were collected through face-to-face interviews with the CEOs of Startup E and Startup M, as well as email correspondence with a representative of Innovation Intermediary S. Additionally, secondary data were extensively gathered, including news articles, company websites introducing the innovation intermediaries, large companies, and startups, promotional press materials, and video recordings of PoC performances by each startup. These sources were incorporated into the research. The study also incorporated insights from an interview with Startup M regarding the open innovation program hosted by Innovation Intermediary Z, an interview article featuring a representative from Company H conducted by Startup M, and a video presentation of Startup M's PoC performance. The data collected from interviews and other sources were structured using the Gioia Methodology, a qualitative research approach designed to identify key elements in the role of innovation intermediaries. The Gioia Methodology provides a framework for conducting inductive research with qualitative rigor while fostering the potential to generate new concepts and ideas, making it particularly suitable for case studies (Gioia & Pitre, 1990; Gioia, 2023).

Table 2. Functions and Activities of Innovation Intermediaries

Roles	Features	Activities
Facilitating collaboration	Prediction and diagnostics	- Foresight and forecasting - Aligning needs and requirements
	Search and information processing	- Scanning and technical information - Scoping and filtering
	Knowledge processing, creation and recombination	- Combine knowledge from other partners - Create and recombine new knowledge
	Commercialization	- Marketing, support, and planning - Sales networks and sales - Explore and fund potential capital sources
Connecting actors	Gatekeeping and brokering	- Matching and brokering by negotiation and trade decisions - Provide contract advice
	Evaluate your results	- Skill assessment
Providing services for stakeholders	Testing and validation	- Test, diagnose, inspect, and analyze - Prototyping and pilot testing - Updating specifications - Validation - Training
	Certification of standards	- Provide advice on specification setting or standards - Setting and validating official standards
	Validation and regulation	- Regulations - Self-regulation - Informal regulation and coordination
	Protecting the fruits of collaboration	- Intellectual property advice on the fruits of collaboration - Manage intellectual property rights for customers

Source: Adapted from Howells (2006), Lopez-Vega & Vanhaverbeke (2009)

First, we summarize the roles and functions of innovation intermediaries as shown in the table above. Innovation intermediaries are primarily responsible for facilitating cooperation among innovation actors, connecting innovation actors, and providing services to stakeholders.

Next, based on resource dependence theory and core competency theory, we first summarized the core elements required for innovation intermediaries and conducted interviews based on core element-centered questions to derive the second core element for the role of innovation intermediaries.

Step1 First Order Concept

By synthesizing the literature and face-to-face interviews, we derived the roles required for innovation intermediaries. Specifically, from the perspective of resource dependence theory, we identified the necessary elements for innovation intermediaries as: identifying the collaboration points required by each party to broker appropriate resources, working to build trust and understanding between each party, resolving misunderstandings or conflicts about corporate culture between each party for smooth communication, establishing strategies to identify and mitigate potential risk factors, and providing legal and regulatory expertise (Howells, 2006). From the perspective of core competency theory, the competencies required for innovation intermediaries were identified as: researching technological development trends related to the business field and providing the necessary information to each party (Liu, 2021), providing networking opportunities for each party to connect with industry experts and government agencies, providing expert mentoring to each party to facilitate open innovation, brokering appropriate funding for startups (Leitão et al., 2022), analyzing the characteristics and needs of startups, and providing consulting to establish and implement customized marketing strategies.

Step2 Second Order Concept

(1) Case of Company L, Startup E, and Innovation Intermediary S

Based on the interviews, the following factors were identified as key elements from the resource dependence theory perspective: identifying the collaboration points each party needs to broker the necessary resources and working to build trust and understanding between each party. From the core competency theory perspective, the key elements identified were: understanding the technology of the parties and recognizing the necessary technology in the process of open innovation, providing marketing to commercialize and sell the product, providing expert mentoring during the open innovation process, and brokering appropriate funding for startups.

(2) Case of Company H, Startup M, and Innovation Intermediary Z

Based on the interviews, the following factors were identified as key elements from the resource dependence theory perspective: identifying collaboration points where each party needs to broker the necessary resources, quickly communicating PoC contents, and resolving potential risk factors in advance. From the core competency theory perspective, the key elements identified were: brokering appropriate funding for startups, specifying the needs of the demanding company, and clearly recognizing the needs of the supplier company.

Step3 Aggregate Dimensions

(1) Case of Company L, Startup E, and Innovation Intermediary S

By structuring the results of the interviews and inquiries, the key elements of the role of an innovation intermediary in the open innovation process between large companies and startups were identified as brokering open innovation with an emphasis on interdependence, maximizing the technological innovation capabilities, marketing capabilities, and organizational capital capabilities of the parties involved, and providing follow-up funding based on PoC performance.

(2) Case of Company H, Startup M, and Innovation Intermediary Z

After structuring the results of the interviews and inquiries, the key elements of the role of innovation intermediaries in the open innovation process between large companies and startups were identified as brokering open innovation with a focus on interdependence, prompt communication and problem handling during the PoC process for resource brokering, resolving potential risk factors during the PoC process, maximizing the technological innovation capabilities, marketing capabilities, and organizational capital capabilities of the parties involved, clarifying and sharing the needs of the demanding companies, and providing follow-up funding based on the PoC results.

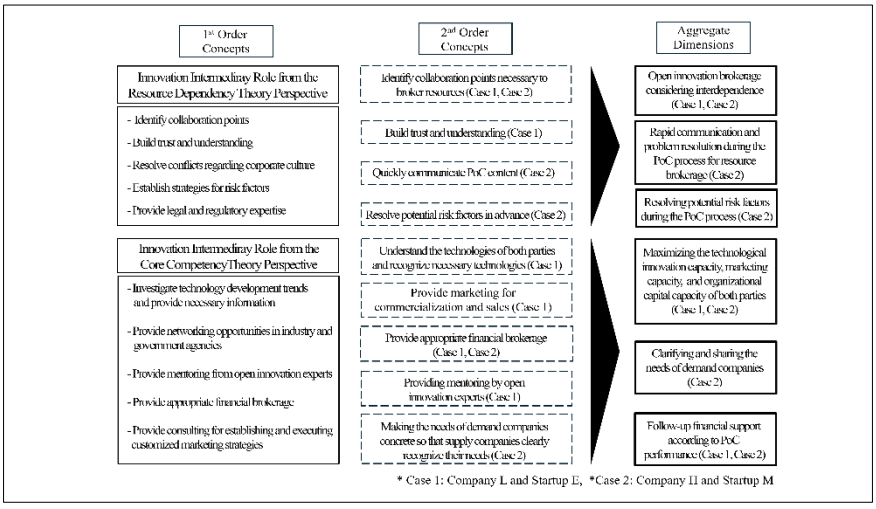

Figure 2. Extracting Key Elements of the Role of Innovation Intermediaries, based on In-depth Interviews

IV. Research Results

1. The Role of Innovation Intermediaries from a Resource Dependence Theory Perspective

1.1 Case of Company L, Startup E, and Innovation Intermediary S

Looking at the role of innovation intermediaries from the perspective of Pfeffer and Salancik's (2003) resource dependence theory, by participating in the open innovation organized by Innovation Intermediary S, Company L, a demand company, can easily obtain the necessary resources by being in an environment where it can share technologies and ideas to advance its technology in the field of digital X-rays, while conducting PoC verification with Startup E under the intervention of Innovation Intermediary S.

From the perspective of Pfeffer and Salancik's (2003) resource dependence theory, interdependent relationships with external organizations that possess the core resources required by the organization are essential for its survival (Cho et al., 2018). As a representative from BS Business Headquarters, which oversees Company L, a large company in the Open Innovation led by Innovation Intermediary S, said, "Digital X-ray is a new business for BS Business Headquarters, and it is a market with high entry barriers and few players in the field. Therefore, the role of an innovation intermediary such as Innovation Intermediary S is required to generate sales through effective B2B sales."

"As part of our new business, we wanted to enter the digital X-ray field. We have excellent capabilities in production, sales, and marketing, but we lacked open innovation operational know-how and technical skills in the digital X-ray field. We were worried about how to successfully promote this business, and fortunately, with the help of the open innovation program of Innovation Intermediary S, we were able to fill in the gaps."(Representative from the BS business headquarters *of Company L)*

On the other hand, Startup E also needed interdependence with external organizations such as large companies. Startup E is an early-stage startup with four years of experience and five employees, but it lacks internal resources to commercialize the technology it has developed (Zheng et al., 2022), and its employees have low practical expertise, so open innovation with a large company, Company L, is necessary. According to the interview, the representative of Startup E said that by conducting open innovation with large company L through the open innovation program led by Innovation Intermediary S, the startup was able to motivate employees internally and mature its technology.

Startup E has outstanding technologies such as the world's first high-performance digital CNT X-ray device over 150kV and an X-ray generator with a high-voltage drive. However, because it is in its early stage, it is not easy to secure investment funds to expand sales and upgrade technology for scale-up. Therefore, Startup E participated in the Open Innovation Program hosted by Innovation Intermediary S and conducted open innovation with Company L.

"Our startup has excellent technology in the field of CNT X-ray tubes and generators. However, as a startup, we were relatively lacking in brand competitiveness and marketing and sales capabilities, and we were struggling with business scalability and investment. While looking for a solution, we were given the opportunity to collaborate with a large company, Company L, through the Open Innovation Program Hosted by Innovation Intermediary S, which gave us the opportunity to improve our brand competitiveness and attract investment. (CEO of Startup E)

From the perspective of resource dependence theory, in the digital X-ray business, Company L has a variety of resources such as capital and manpower, but it does not have all the resources itself, especially digital X-ray technology. In addition, Startup E has high technology, but due to the limitations of early startups, it lacks funds and has difficulties in commercializing and expanding its technology. Therefore, Innovation Intermediary S connected Company L and Startup E to carry out open innovation, brokering the resources needed by each company, reducing the exploration cost of open innovation between large companies and startups (Zhang & Li, 2010), and enabling them to secure the external resources needed by each other through this intermediation.

The coordination and mentoring of innovation intermediaries provide specialized guidance and support to startups, helping them to learn from relevant experts, make informed decisions, and ultimately create innovative products (Salvador, 2011; Bliemel et al., 2016; Cohen et al., 2019; Clarysse et al., 2005). As Innovation Intermediary S uses open innovation experts in the process of intermediation between companies, it does not stop with just identifying the demanding company and the startup and introducing them to each other. In the Open Innovation Program hosted by Innovation Intermediary S, an open innovation expert is assigned to the startups for one-to-one mentoring throughout the 11-week program to increase the chances of collaboration success. In this way, Innovation Intermediary S provides close operational services throughout the program and offers customized care for participating companies. From the perspective of Howells' (2006) functions and roles of innovation intermediaries, this can be seen as innovation intermediaries facilitating cooperation between innovation actors. In other words, Innovation Intermediary S also provides customized services in terms of marketing during

the program. In addition, Innovation Intermediary S helps to explore potential sources of capital funding. This is embodied by acting as a bridge for demand companies looking for new sources of investment to invest directly in the startups they collaborate with, and by helping them identify companies for investment in the innovation intermediary's dedicated fund and attract multiple investors.

1.2 Case of Company H, Startup M, and Innovation Intermediary Z

Looking at the role of innovation intermediaries from the perspective of Pfeffer and Salancik's resource dependence theory, by participating in the open innovation hosted by Innovation Intermediary Z, the demand company H can easily secure the resources it needs by sharing its video-based visitor data analysis solution technology with Startup M through PoC verification under the intervention of Innovation Intermediary Z. Company H opened an ambitious showroom on Songpa-daero, and since there was no way to scientifically measure the performance of the showroom, they were looking for a startup with a solution to solve this problem. As a representative of Company H in the open innovation organized by Innovation Intermediary Z said, it was not easy to analyze customer data at the Songpa-daero branch, so they needed the help of Innovation Intermediary Z, which intermediates startups with relevant resources, to conduct marketing by understanding the customer's purchase journey.

"As more and more customers come to the Songpa-daero branch for autonomous experiences during the day or to visit the no-contact showroom at night, there are more and more customers who walk around the showroom alone. And nowadays, customers do not move linearly in the purchase journey, so it is not easy to know at what stage they come, such as whether they are just exploring or are in a state of conviction to buy. However, Innovation Intermediary Z was able to solve the problem by brokering a startup that could solve the problem we had through its own open innovation." (Representative from Company H)

On the other hand, Startup M also needed mutual collaboration with external organizations such as large company H. Startup M was a young startup with 1.2 years of experience at the time of the PoC with Company H. It had a video-based data analysis solution, but lacked the resources to commercialize it (Zheng et al., 2022). According to the interview, the representative of Startup M needed a sales network with a large company from the beginning to conduct B2B sales to large companies, and through open innovation with large company H, led by Innovation Intermediary Z, they were able to verify their technology and secure customers through B2B sales to other large companies.

Startup M has a solid team organization specialized in video analysis AI research and has excellent technology for video-based data analysis solutions. However, since it was in its early stages, it needed a large company's sales performance to increase B2B sales, and it was not easy to raise funds, such as for server costs for video analysis. Therefore, Startup M participated in the Open Innovation Program hosted by Innovation Intermediary Z and conducted open innovation with Company H.

"We have a team organization and technology specialized in video-based data analysis solutions. However, because we were still in the early stages, we lacked sales power to large companies, and above all, we had no track record of large companies using our solution. We were also facing difficulties in securing funding, as we were incurring excessive server costs for video analysis due to the early stage. To solve this problem, we applied to the Open Innovation Program organized by Innovation Intermediary Z and performed well in the PoC for six months. As a result, we were able to secure other companies in Company H's group and other large companies as customers." (CEO of Startup M*)*

From the perspective of resource dependence theory, Company H has resources such as marketing capabilities and capital, but it does not have all the resources at the group level, and its technology for video-based data analysis is somewhat lacking. Startup M has high technology in the field of video-based data analysis, but it lacks the ability to secure funds to expand its business and is struggling with commercialization to conduct B2B sales through this technology. Therefore, Innovation Intermediary Z connected Company H and Startup M to conduct open innovation, brokering resources for each company, and each company was able to secure the resources they needed. In an interview, the CEO of Startup M said that without an innovation intermediary, it would have been difficult for them to communicate with a large company in an open innovation process, to clearly recognize whether they had the resources that the large company wanted and whether the resources they had were needed by the large company. With the help of Innovation Intermediary Z, Startup M was able to find Company H, which was able to match its technological needs.

"Without Innovation Intermediary Z, we would not have known if we had the resources that Company H was looking for, and vice versa, if we had the resources that Company H needed. With the intermediary help of Innovation Intermediary Z, we were able to communicate with Company H, and when we met with Company H's on-site team, we were able to clearly and quickly resolve how to proceed with specific PoCs and validate them, even if we didn't know each other well." (CEO of Startup M*)*

In particular, it is not easy for large companies and startups to communicate smoothly because they have different corporate cultures (Dobre, 2016). Innovation Intermediary Z helped Startup M communicate with Company H by teaching them how to communicate with the on-site team and solving problems that arose during the PoC verification process.

"We all know that the culture of a large company and the culture of a startup are different. However, the gap is much bigger than I thought, so I thought it would be necessary to bridge the gap. For example, communication with large companies is often done through documents, and we lacked some capabilities in this area, and Innovation Intermediary Z helped us to communicate according to our situation." (CEO of Startup M*)*

A potential risk factor in open innovation between Company H and Startup M is the inability to install CCTV inside the vehicle showrooms and dealerships operated by Company H. However, Innovation Intermediary Z worked out a solution with Company H to install CCTVs in newly opened showrooms, such as the Songpa-daero showroom, so that Company H and Startup M could verify the PoC from the beginning.

"Company H, a large company, was unable to install CCTV inside its dealerships and showrooms due to its own issues. Innovation Intermediary Z recognized this in advance and coordinated with Company H to resolve the issue. As a result, it was agreed that CCTV could be installed only in newly opened stores. Since the Songpa-daero store was newly opened at the start of the PoC, the company was able to set up a CCTV installation site with Company H to gain insights into customer data analysis, and the CCTV was installed successfully." (CEO of Startup M*)*

2. The Role of Innovation Intermediaries from a Core Competency Theory Perspective

2.1 Case of Company L, Startup E, and Innovation Intermediary S

In the current rapidly changing technological environment and fierce competition, companies need to continuously strengthen their core competencies to gain a competitive advantage. According to the structured results of the interviews and inquiries, the core competencies required in the role of innovation intermediaries are to maximize the technological innovation capabilities, marketing capabilities, and organizational capital capabilities of companies. In the case of Company L, a large company, it has the marketing and organizational capital capabilities to identify customer needs and provide

products or services that meet them because of its production capacity and rich experience in manufacturing products. However, the BS business headquarters within Company L has selected the digital X-ray field under IT/robotics as a new business, but it is still in the early stage, so it lacks technological innovation capabilities because the digital X-ray technology is underdeveloped. On the other hand, Startup E has technological innovation capabilities in that it has X-ray generator technology with high-performance digital CNT X-ray elements, but it lacks marketing capabilities to develop and commercialize this technology, and it also has limited organizational capital capabilities due to insufficient funds for business expansion, including factory construction, and a lack of experience in product manufacturing. In this situation, Innovation Intermediary S analyzed the core competencies of Company L and Startup E through Open Innovation organized by Innovation Intermediary S, maximizing the core competencies of each and appropriately mediating the lacking competencies. In other words, Company L increased its technological innovation capabilities by minimizing initial investment and reducing potential risks before product development through PoC verification of Startup E's X-ray generator technology, including digital CNT X-ray elements. Startup E, in turn, secured marketing capabilities and organizational capital capabilities by receiving help with initial product development and commercialization through open innovation with Company L. On the other hand, it is important for employees in charge of a large company to have know-how about the new business and for the company to have an appropriate organizational system. However, in the case of Company L, it had only recently entered the digital X-ray field and had a very short history with its in-house open innovation office. In this situation, as a representative from the BS business headquarters of Company L said, Open Innovation hosted by Innovation Intermediary S helped the representative acquire know-how in open innovation practices. In other words, as a representative from Company L who had just started open innovation work and lacked experience, he received advice from employees of Innovation Intermediary S on how to run an open innovation program, how to properly communicate with startups that are different from the culture of large companies, and how to collaborate.

"Basically, I had just started working as an open innovation officer, so I had no experience. I received a lot of help from various representatives of Innovation Intermediary S on how to run such a program, how to communicate with startups properly, and how to work together." (Representative from the BS business headquarters of Company L)

2.2 Case of Company H, Startup M and Innovation Intermediary Z

Structuring the results of the interviews and inquiries, the core competencies required for the role of innovation intermediaries are to maximize the

technological innovation capabilities, marketing capabilities, and organizational capital capabilities of companies. In the case of Company H, as a global conglomerate, it has the marketing capability to reach a large number of customers and the organizational capital capability in terms of excellent financial strength for business operations. However, Company H lacks technological innovation capabilities in terms of solutions that can scientifically and objectively measure the performance of its dealerships and showrooms or analyze visitor data.

On the other hand, Startup M has a video-based visitor data analysis solution with AI technology and possesses the technological innovation capability to analyze visitor data, but it lacks the marketing capability to generate B2B sales through this technology, and it also lacks organizational capital capability due to insufficient financial strength to cover high server costs for data analysis.

In this situation, Innovation Intermediary Z analyzed the core competencies of Company H and Startup M through its own open innovation process and then mediated to help them maximize their weak competencies. In other words, through Startup M's video-based visitor data analysis solution, Company H was able to learn which cars visitors are interested in at the showroom, how many customers come during the day and night, and the customer purchase journey of the visitors, thereby enhancing its technological innovation capabilities. Startup M was able to secure marketing and organizational capital capabilities with the help of technical verification and funding for its initial product.

The analysis of the interview with the CEO of Startup M highlights the importance of the process of refining the vague innovation needs of large companies. In particular, we found that innovation intermediaries play a key role in translating abstract needs, such as "digital transformation of offline stores," into clear goals, such as "quantifying the customer experience when visiting offline stores." This means that innovation intermediaries go beyond providing information to facilitate communication between large companies and startups, crystallize innovation challenges, and drive successful collaboration. These results suggest that it is important for innovation intermediaries to have the ability to accurately identify the innovation needs of large companies and effectively communicate them to startups.

Interviews on the role of innovation intermediaries in funding and investment connections reiterated the importance of funding for startup growth. In particular, startups in the image processing sector were faced with the high cost of building high-performance servers to process massive amounts of data. In this situation, funding from innovation intermediaries played a crucial role in driving the initial growth of startups. Additionally, the investment linkages guaranteed by innovation intermediaries acted as a catalyst for securing investor confidence in the process of attracting subsequent investments and facilitating investment decisions. This means that innovation intermediaries go beyond a simple

intermediary role and provide practical help in securing funding, an essential resource for startups to grow.

3. Insights from Two Examples of Open Innovation

In the case of Startup E, despite a successful two-year PoC with Company L, they struggled to attract follow-on investment. This highlights the practical limitations of securing investors based on PoC results alone. In particular, in the absence of concrete results such as signing a mass production contract, investors are likely to question the future growth potential of the startup. This suggests that even if a startup successfully conducts PoC through open innovation, additional efforts are needed to commercialize and attract investment.

Startup M used its PoC success with Company H to expand its B2B business with various large companies and successfully attract investment. This is a prime example of how PoC results can lead to real business opportunities beyond mere technology validation. In particular, the innovation intermediary's subsequent investment support played an important role in the growth of Startup M, which suggests that innovation intermediaries should go beyond just connecting and provide practical support for startups' growth.

Company L did not invest its own funds in Startup E during the PoC process, and Company H did not directly invest funds in Startup M. However, by successfully carrying out open innovation, Startup M was able to smoothly attract follow-up investment and expand B2B to other affiliates of the company, which helped increase sales.

In the process of open innovation, both Startup E and Startup M achieved excellent results within a given period. In the case of Startup E, the successful PoC verification with Company L earned them the Collaboration Excellence Award in the Open Innovation Program hosted by Innovation Intermediary S, while Startup M excelled in PoC verification with Company H, leading to B2B sales results that expanded Startup M's data analytics technology to other stores managed by Company H.

Additionally, Startup E conducted PoC verification with Company L three times after the open innovation program and advanced the core components that go into digital X-rays. Startup E also began B2B collaboration with other stores of Company H, as well as other subsidiaries of Company H.

However, in the case of Startup E, after the open innovation program, it did not receive funding, brokerage, or investment attraction linkage from Innovation Intermediary S. While it advanced its product with Company L, it has paused the PoC for a while. On the other hand, in the case of Startup M, after the open innovation program, it received investment from investors based on the performance of its PoC, and Innovation Intermediary Z also invested in it.

Taken together, the above two examples show that innovation intermediaries should play a variety of roles to support startups' growth after PoC, beyond just connecting large companies and startups. In particular, it is necessary to attract investment and provide follow-up funding so that PoC results can lead to actual commercialization. Innovation intermediaries should also provide ongoing mentoring and support to help startups achieve concrete outcomes, such as signing mass production contracts.

V. Conclusion

This study analyzed the role of innovation intermediaries in open innovation between large companies and startups from the perspectives of resource dependence theory and core competency theory, using the open innovation cases of Company L and Startup E, and Company H and Startup M. Based on the findings, the following implications can be drawn. First, the role of innovation intermediaries is crucial for open innovation between large companies and startups. Companies that maintain close relationships with innovation intermediaries can efficiently secure the necessary resources, thereby enhancing their capabilities, speed, and flexibility in open innovation (Zhang & Li, 2010). Second, from the perspective of resource dependence theory, it is important for large companies to upgrade their technology and acquire necessary resources through open innovation with startups. In particular, even if a large company has abundant internal resources and can solve its own problems, technical collaboration with startups in the early stages of a new business can save time for technological upgrading, as shown in the case of Company L. Third, in terms of core competencies, it is necessary for both large companies and startups to accurately analyze their core competencies and complement each other's competencies, which can be achieved through open innovation facilitated by innovation intermediaries.

Despite these implications, this study is based on two case studies, and further research is needed for generalization (Yin, 2014). Specifically, there are limitations to generalizing the findings, as this study focused on the cases of Innovation Intermediary S and Innovation Intermediary Z to analyze the role of innovation intermediaries in open innovation between large companies and startups. Additionally, this study relies primarily on qualitative research methodology and lacks quantitative analysis of the role of innovation intermediaries. Furthermore, since this study is based on data from a specific point in time, it is difficult to identify changes in the role of innovation intermediaries from a long-term perspective. The study also lacks analysis of different types of innovation intermediaries. There are many different types of innovation intermediaries, and each may have distinct roles and functions.

Therefore, future research should, first, further explore the cases of innovation intermediaries to generalize the role of innovation intermediaries in open innovation. Second, researchers should conduct surveys to quantitatively analyze the impact of specific activities of innovation intermediaries on firm performance. Third, long-term follow-up studies of the same firms are needed to analyze the relationship between changes in the role of innovation intermediaries and firm growth, and to examine the ongoing role of innovation intermediaries. Fourth, research is needed to compare and analyze various types of innovation intermediaries, such as government agencies, universities, and private companies, to identify the characteristics and effects of each type and propose an optimal innovation intermediary model.

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