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**Article**

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# An Analysis of Critical Factors Affecting the Success of Open Innovation Strategies in High-Tech Firms: The Case of South Korea

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**Abstract:** High-tech firms face constant innovation and challenges due to a rapidly changing tech environment. Open innovation strategies are an important solution for fostering rapid and efficient innovation by leveraging external capabilities. This study explores the critical factors that influence open innovation strategies in high-tech companies, assessing their importance and providing key insights for promoting these strategies. Through a comprehensive literature review and expert interviews, 16 key factors impacting open innovation were identified. A hierarchical research model was developed using the ser-M (subject, environment, resource, mechanism) framework, focusing on subject, environment, resource, and mechanism for a corporate strategy analysis. A survey and an AHP analysis were conducted with 30 participants, comprising engineers and open innovation experts, all with over a decade of experience in the field within Korean high-tech companies. The analysis focused on four critical elements: subject, environment, resource, and mechanism; subject emerged as the most critical factor for successfully implementing open innovation strategies. Specifically, the will of chief executives, the direction of decision-making, and technological environment changes were found to be significant contributors. The consensus between engineers and experts confirms that while environmental and resource factors are vital, strong leadership and effective decision-making are paramount for successful open innovation in high-tech companies.

**Keywords:** open innovation; success factors; high-tech company; AHP; ser-M model



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## 1. Introduction

Recently, firms have been faced with a rapidly evolving technology landscape, encompassing high-performance semiconductors, artificial intelligence, bio-technology, and digital transformation. Concurrently, the market environment is undergoing a period of significant transformation, with the dissolution of traditional boundaries between online and offline, national and regional markets, and the introduction of a multitude of innovative products. Furthermore, a number of regulatory changes, shorter product life cycles, and rising technology development costs are impeding the capacity of organizations to maintain market competitiveness based on their internal capabilities alone (Van de Vrande et al. 2009).

Therefore, firms are extending their open innovation strategies in order to maintain their competitive advantage and innovate in response to changes in the external environment (Teece 2020; Gassmann et al. 2010). Open innovation can be an effective corporate strategy for the development of creative technology. It enables firms to innovate and acquire specialized external capabilities and knowledge, thereby overcoming the limitations of fixed, conventional thinking and technology development methods within the firm (Felin and Zenger 2014). Furthermore, it can facilitate the expeditious acquisition of scarce intellectual assets and capabilities within the firm while concurrently reducing R&D costs.

In a recent study, Staack and Cole (2020) surveyed nearly 1200 companies and found that there has been a notable shift in the industry towards more inclusive operating models.

These models include open innovation, design thinking, and collaboration with customers, partners, and suppliers, which are becoming increasingly prevalent in the business landscape. Furthermore, INSEAD and Ipsos (2023) indicated that 72% of European companies are currently engaged in open innovation initiatives, with over 69% of companies expressing an interest in collaborating with startups over the next 18 months.

According to a 2023 survey of more than 1000 global companies with annual sales of more than USD 1 billion conducted by the U.S.-based research and consulting firm Capgemini, 75% of companies surveyed believe open innovation plays a critical role in solving complex organizational challenges. In addition, 83% of companies surveyed cited open innovation as a pivotal factor in achieving their sustainability goals. The majority of respondents (55%) said open innovation has accelerated the pace of corporate innovation. In addition, 62% of respondents said open innovation has a positive impact on the agility and adaptability of their workforce.

In South Korea, in particular, more than 60% of companies said they had realized financial benefits, including increased revenue and operational efficiency, from open innovation. This demonstrates the wide range of benefits these organizations can gain from open innovation. In addition, more than 71% of these organizations said they plan to increase their spending on open innovation over the next two years to prepare for an uncertain future.

In particular, in recent years, companies in high-tech industries such as semiconductors, biology, and artificial intelligence have been employing open innovation strategies as their technology development strategies. This is achieved by collaborating with external partners, sharing knowledge, and utilizing external ideas with the aim of developing rapid and innovative technologies and securing market competitiveness (Vanhaverbeke et al. 2008; Radziwon and Bogers 2019; Zarzewska-Bielawska 2012; Bertello et al. 2024).

As posited by Radziwon and Bogers (2019), high-tech firms endeavor to augment their innovation capabilities and competitiveness in a rapidly evolving technological milieu by espousing open innovation as a conduit through which to respond to the advent and evolution of novel technologies. Moreover, high-tech firms prioritize flexibility in their innovation processes and organizational structures.

Consequently, they endeavor to cultivate an open organizational culture and advance technological innovation through the strategic integration of their internal and external resources (Colombo et al. 2010). This enables an organization to retain financial flexibility, thereby facilitating the pursuit of a more expansive range of innovation activities, which, in turn, fosters capacity development and innovation (Satta et al. 2016). From an economic standpoint, open innovation strategies mitigate the financial burden and potential liabilities associated with the innovation process, enabling technology companies to procure cutting-edge technologies and solutions in a more cost-effective and streamlined manner (Strazzullo et al. 2023).

Prior research on open innovation has been conducted with the objective of identifying its outcomes (Parida et al. 2012; León et al. 2019; Rogo et al. 2014; Lamberti et al. 2017). Additionally, several studies have aimed to delineate open innovation practices (Nayebi and Ruhe 2014; Sovacool et al. 2017; Michelino et al. 2017). Nevertheless, the majority of these studies have concentrated on particular projects or on substantiating the outcomes and effects of open innovation.

In recent times, as open innovation has become a methodology utilized by a multitude of firms, the discourse has progressed from its initial focus on R&D and technological innovation to encompass a more strategic level of analysis, with ramifications for business operations and the creation of new markets. At this juncture, it is imperative to identify the factors that can facilitate open innovation and to examine the critical factors for decision-making and the successful implementation of open innovation strategies.

A review of the literature reveals that open innovation has a positive impact on companies in tangible and intangible ways. Additionally, 16 factors, including innovative leadership, competitive intensity, and collaborative control systems, have been identified as

influencing the success of open innovation strategies. Among the 16 factors, our findings indicate that top management leadership and decision-making, corporate absorptive capacity, and organizational system and culture exert a considerable influence on the success of open innovation. The objective of this study was to empirically verify the relative importance and priority of these factors.

To this end, we wanted to analyze how much top management leadership influences the success of open innovation in the field and whether the impact of financial investment, technology modularization, etc., on the success of open innovation is evaluated differently depending on job characteristics and what are the common perceptions between the two comparison groups.

This study aims to identify the critical factors of open innovation strategies for enhancing the competitiveness of high-tech companies and to analyze the importance of these factors. This study derives the critical factors that affect successful open innovation strategies and provides specific implications for companies to make decisions and effectively operate open innovation strategies.

As a preliminary step, we identified 16 open innovation success factors through a review of the literature and a Delphi survey, and we subsequently organized them into a hierarchical structural model comprising four superordinate variables: subject, environment, resources, and mechanisms. Subsequently, an AHP-based survey was conducted on the predefined structural model for open-innovation-related personnel in Korean high-tech companies.

The data obtained through the survey were analyzed using AHP to derive insights regarding the relative importance and priority of the factors, with the aim of elucidating the conditions necessary for the success of open innovation. As open innovation has emerged as a prominent strategy among high-tech companies in recent years, the insights and implications derived from this study will prove invaluable for high-tech companies seeking to enhance their innovation and competitiveness.

The remainder of this thesis is organized as follows. In Section 2, we review the literature on the open innovation strategy and its influencing factors. Section 3 describes the research model design and methodology, including AHP. Section 4 compares and analyzes the AHP results of the engineer group and the open innovation expert group, and finally, this paper summarizes the discussion and implications of the results in Sections 5 and 6.

## 2. Literature Review

### *2.1. Open Innovation Strategy*

Open innovation represents a methodology for corporate innovation that enables companies to reduce innovation costs and increase the likelihood of success by leveraging external resources throughout the innovation process, including research, development, and commercialization (Chesbrough 2003). The practice of open innovation enables companies to proactively engage with external ideas and resources throughout the stages of idea exploration, R&D, and commercialization. This approach facilitates the development of novel technologies and products. In light of the aforementioned, it can be posited that open innovation strategies may be defined as corporate innovation activities that enhance the probability of success in R&D activities and new business (Chesbrough 2006a; Chesbrough and Crowther 2006).

The initial concept of open innovation was predicated on the notion of leveraging external resources in the R&D process, with the objective of enhancing the probability of success. The advent of open innovation was propelled by a confluence of factors, including the consolidation of knowledge by major corporations, the escalating costs associated with technological advancement, the shrinking lifespan of products due to rapid technological and market shifts, the exponential growth in the volume of knowledge, the acceleration of new technology development, and the emergence of venture capital and the mobilization of R&D talent (Chesbrough 2006a; West and Bogers 2014).

In regard to R&D activities, open innovation has been emphasized as a way for firms to break free from the limitations of existing internal resources and actively engage with external resource exchanges and knowledge mediation in a dynamic and competitive environment (Lichtenthaler and Lichtenthaler 2009; Enkel et al. 2009).

However, in recent years, the rapid and complex environmental changes affecting technology, markets, and regulations have led to a broadening of open innovation strategies beyond R&D innovation, with a corresponding shift in focus towards business model innovation. Consequently, the concept of open innovation is being re-framed as a more expansive innovation process that transcends the conventional boundaries of organizational structures (Chesbrough 2007; Chesbrough and Bogers 2014; Saebi and Foss 2015) (see Figure 1).

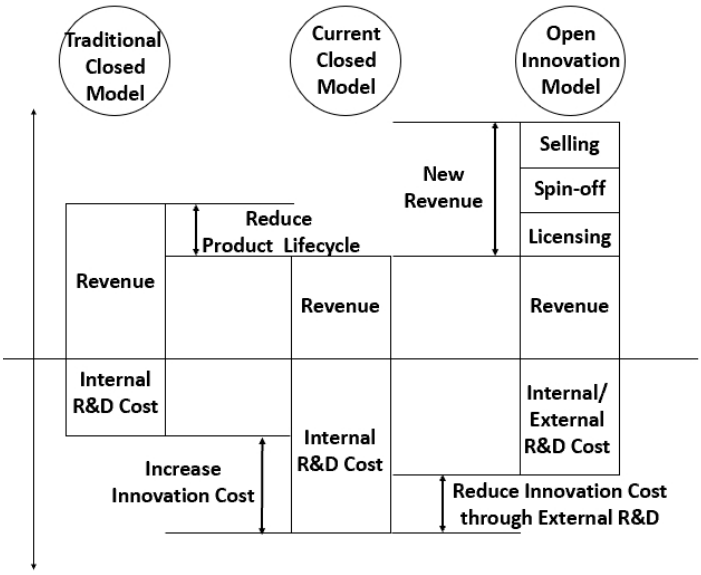


**Figure 1.** Comparison of closed and open innovation. Source: Chesbrough (2007).

In instances where internal organizational innovation performance is inadequate, firms implement an open innovation strategy that encourages external collaboration in a multitude of ways, thereby securing the requisite competitive advantage (Asad et al. 2023; Bejarano et al. 2023). The implementation of enhanced open innovation strategies enables organizations to identify novel solutions, distribute risks and rewards, and achieve accelerated market competitiveness through collaboration with external partners, as opposed to relying on internal development alone (Radziwon and Bogers 2019; Sieg et al. 2010).

Open innovation strategies are classified into inbound, outbound, and coupled types (see Table 1). Inbound open innovation represents a specific approach to innovation that draws upon the ideas and intellectual assets of external organizations, as well as those of independent researchers and academics, in the product and technology development process. It manifests in the following forms: joint development with external organizations or companies, license-ins, venture investment, and mergers and acquisitions (Hasnas et al. 2014; Parida et al. 2012; Getz and Kaitin 2012).

Outbound open innovation refers to the practice of a company exporting its internal technology to external entities for commercialization through alternative routes, typically when the internal business model is unable to facilitate the desired commercialization of the technology in question. In particular, spin-offs and license-outs are often used (Ettlinger 2017; Trabucchi et al. 2018). Regarding the final category, the coupled type promotes collaborative partnerships between organizations to jointly develop and commercialize technologies and services with complementary partners, in addition to inbound and outbound open innovation (Sandmeier et al. 2004).

**Table 1.** Open innovation modes.

| Separation | Concepts | Innovation Process Highlights | Company Characteristics |
| --- | --- | --- | --- |
| Inbound | Expand its own knowledge base and increase innovation through the introduction of external knowledge | - Initial integration of external knowledge<br>- Co-develop with users<br>- Introduction and integration of external knowledge | - Companies with high technology modularization<br>- High knowledge intensity |
| Outbound | Exporting its own technology to external parties and monetizing it through other channels | - Commercialization of ideas<br>- Licensing out and patent sales | - Aim to reduce R&D costs and standardization through technology spin-offs |
| Coupled | Integrate inbound and outbound open innovation by partnering with complementary partners | - Integrate inbound and outbound processes<br>- Integrate external knowledge and competitiveness internally and spread internal knowledge and competitiveness externally | - Technology standardization and industrial mobilization through doubling of technology |

An open innovation strategy can reduce costs and facilitate rapid product development by sharing and leveraging knowledge and resources with external partners (Keupp and Gassmann 2009; Van de Vrande et al. 2009; Hung and Chou 2013). It can also enable collaboration with various players and ensure the ability to explore new knowledge and information.

Consequently, companies are able to expedite the creation of new products and services while concurrently reducing costs. This process plays a pivotal role in enhancing R&D and accelerating the product development process (Bogers et al. 2017). Moreover, by leveraging external resources, such as customers, suppliers, and partners, companies can more readily access specialized knowledge from a broader perspective and awareness. In other words, the scope of innovation can be expanded by incorporating diverse external ideas and technologies.

In particular, open innovation strategies can facilitate the accelerated market entry of new products and services for technology-based firms, thereby ensuring a competitive advantage (Dilrukshi et al. 2022). They facilitate the attainment of creativity and innovation, which would be difficult to obtain with only the limited resources inside the firm (Yulianto and Supriono 2023; He and Liu 2011).

This has advantageous effects on the outcomes of the firm by enabling the launch of new products and services quickly and at the right time (Gassmann et al. 2010). Moreover, as evidenced by the findings of Pisano and Teece (2008), sustaining and fostering a consistent level of open innovation for technology can result in a reduction in firms' R&D expenditures. This approach can facilitate the formation of strategic alliances aiming to establish new technological standards (Dahlander and Gann 2010; Gassmann et al. 2010; Carbone et al. 2012).

In addition, studies have been conducted on cases where open innovation strategies have enabled companies to respond appropriately to unexpected external environmental changes and technological advancements to transform their organization and business models and create opportunities in times of crisis. Radziwon et al. (2022) employ ecosystem effectuation theory and open innovation to elucidate how Air Asia, an air transportation company, was able to reinvent itself as a "digital lifestyle platform" company through convergence with digital technologies during the COVID-19 pandemic.

In order to survive the extreme crisis of the pandemic, Air Asia creatively leveraged its existing resources to build a new ecosystem. This was achieved through open innovation, whereby the company collaborated with and acquired partners with IT expertise in order to develop a new digitalized business model. In this manner, Air Asia utilized its existing

resources—including the aviation industry and customer data—to establish a lifestyle platform encompassing travel and a novel digitized business model encompassing fintech and e-commerce. This exemplifies how to transcend the simplification crisis to advance long-term innovation and growth.

Furthermore, Liu et al. (2022) highlight that the healthcare industry's accelerated development of new technologies and ability to overcome the crisis through collaboration among various actors during the pandemic exemplify the significance of open innovation. Astra Zeneca's collaborative network of universities, companies, and governments facilitated the expeditious development and large-scale production of a vaccine, exemplifying the pivotal role of co-evolution in the innovation ecosystem. Furthermore, this illustrates that digital technologies and open innovation tools, such as crowdsourcing, have been instrumental in the accelerated adoption and dissemination of telehealth and the expeditious design and production of personal protective equipment, such as masks.

### 2.2. Critical Factors Affecting Open Innovation Strategy

In the context of rapidly evolving business environments, open innovation strategies offer a range of advantages to enterprises, including the potential to enhance competitive advantage and operational efficiency. In particular, they facilitate the transfer of technology and intellectual resources through the establishment of corporate knowledge networks and partnerships. Furthermore, they offer organizations the chance to generate new value, which, in turn, improves their competitiveness, growth, and differentiation as technology firms (Ziviani et al. 2022). The extant literature on open innovation in firms concentrates on the roles of top management, partnerships, firm absorptive capacity, risk management and competitiveness, and internal organizational structure.

Firstly, numerous studies have identified the pivotal role of the top management team (TMT) in an organization's open innovation strategy (Huston and Sakkab 2006; Mortara and Minshall 2011; Wang et al. 2023). As open innovation strategies are highly linked to a firm's business strategy and direction, it is evident that the perceptions and attitudes of the top decision-maker or top management organization exert a considerable influence on the efficacy of open innovation strategies, irrespective of the firm's size.

Lu et al. (2022) posited that the placement of the TMT within the organizational structure is of paramount importance to the success of open innovation. The findings of Wang et al. (2023) indicate that the public commitment of the TMT to open innovation has a positive effect on the promotion of open innovation within the firm. Jespersen (2010) reported that the openness of decision-makers is strongly related to the success of open innovation strategies. Furthermore, Naqshbandi et al. (2019) argued that positive leadership on open innovation strengthens innovation performance.

In terms of studies emphasizing partnerships, Yeung et al. (2021) and Dries et al. (2013) argued that for high-tech firms, open innovation strategies have a positive impact on accelerating the innovation process and product development through collaboration with external technology partners and the sharing of intellectual property. Rumanti et al. (2021) also explained that open innovation strategies allow firms to collaborate with a variety of external parties, such as suppliers, consumers, competitors, and industry. They emphasized that this facilitates the flow of knowledge and information to improve performance and leads to continuous innovation.

Urbinati et al. (2022) posited that companies can effectively pursue radical innovation through equity alliances, acquisitions, and joint ventures. Michelino et al. (2017) proposed that firms can enhance their innovation performance by fostering greater collaboration with external research organizations. Consequently, through the implementation of open innovation strategies, firms are able to leverage both internal and external resources in order to spearhead innovation and enhance revenue through a multitude of market channels. By embracing open innovation, firms reinforce their competitive advantage and intellectual property rights within the marketplace, thereby creating a favorable environment for continued innovation (Niu 2022).

The concept of absorptive capacity, as proposed by Cohen and Levinthal (1990), refers to a firm's ability to acquire, transform, and utilize diverse ideas and technologies from external sources. This capacity has been identified as a critical factor for successful open innovation. Mirza et al. (2022) posited that absorptive capacity exerts a considerable influence on diverse forms of open innovation, including inbound and outbound open innovation and organizational learning capacity. This, in turn, enhances strategic innovation outcomes.

In other words, organizations with a more robust absorptive capacity are better positioned to enhance the efficacy of open innovation, which, in turn, fosters innovation within the organization and ultimately secures a competitive advantage. Gassmann et al. (2010) underscored that in order to drive innovation and remain competitive in a rapidly changing technological environment, it is important for firms to embrace active collaboration with the outside world and internalize external technologies based on a high absorptive capacity.

In a review of previous studies that emphasized risk management and competitiveness, Huang et al. (2020) argued that open innovation should enable firms to mitigate the risks and burdens associated with innovation competition through imitation and learning, thereby maintaining sustainable competitiveness. Lazarenko (2019) explained that companies need appropriate management tools to explore opportunities and effectively mitigate risks, and open innovation can help them prepare for potential risks such as overspending resources and losing differentiation.

In general, high-tech companies tend to have high R&D costs, reflecting the importance of R&D. However, these costs are a burden on firms; thus, actively reflecting and accepting external knowledge in R&D, such as knowledge sharing and diffusion, can reduce the risk of R&D investment and increase the speed of development (Yudanov 2012; Stroh 2019). In essence, as posited by Zhang et al. (2023), an open innovation strategy can effectively promote innovation by leveraging all internal and external resources. Furthermore, by creating new value, it can significantly assist advanced technology firms in differentiating their competitiveness.

A review of the literature reveals a consensus among previous studies that the improvement of internal organization is a key objective. Gaspary et al. (2020) posited that a flexible organizational structure can more effectively support and enhance open innovation strategies, ultimately improving innovation outcomes and success. Miyao et al. (2022) argued that firms can establish an open and flexible organizational culture as well as adopt a multifaceted approach that leverages a variety of internal and external resources. Moreover, as Wang et al. (2023) posited, the establishment of dedicated departments, such as open innovation hubs, and the encouragement of open innovation initiatives can enhance the collective efficacy of organizational members and facilitate innovation activities.

Sá et al. (2023) further asserted that open innovation in organizations is a pivotal strategy for fortifying knowledge management and innovation culture. Cricelli et al. (2023) posited that open innovation effectively leads to open leadership, the formation of knowledge networks, and a flexible organizational structure and culture in technology companies. Consequently, open innovation strategies have a beneficial effect on the development of robust organizational capabilities and an open organizational culture. This is particularly crucial for companies that must maintain competitiveness in rapidly evolving markets, such as high-tech firms (Ober 2022; Rumanti et al. 2021).

Moreover, prior research has identified a number of critical factors that contribute to the effectiveness of open innovation strategies. Zhang et al. (2024) underscored the pivotal role of the top management's capacity for innovation, organizational structure, and learning culture in this regard. Similarly, Ahn et al. (2017) and Bogers et al. (2019) posited that the willingness of top management to embrace innovation, communication, decision-making processes, and the presence of innovation initiatives is a crucial determinant of the efficacy with which open innovation strategies are implemented and managed.

Drechsler and Natter (2012) posited that internal and external knowledge gaps and organizational openness are critical factors in the implementation of open innovation strate-

gies, and Marullo et al. (2018) asserted that the success of open innovation is predominantly shaped by the firm's resources, such as knowledge and skills and networks.

De Faria et al. (2020) and Grama-Vigouroux et al. (2020) highlighted organizational flexibility and culture, the smooth flow of internal and external information, and partnerships as critical factors leading to the success of open innovation. West and Bogers (2014) identified the capacity to explore and absorb external promising innovations, integrate internal and external innovations, and interact with external partners as important success factors for open innovation, particularly in the context of inbound open innovation.

## 3. Methods

### *3.1. Research Design*

As illustrated in Figure 2, this study was conducted in three phases. In the initial phase of the study, the critical factors of open innovation were identified. To this end, we collated and synthesized the findings of prior studies on the critical factors of open innovation strategies. Subsequently, in consideration of the characteristics inherent to the open innovation strategies of high-tech companies, a Delphi survey was conducted with the objective of identifying the factors that contribute to the success of such strategies.

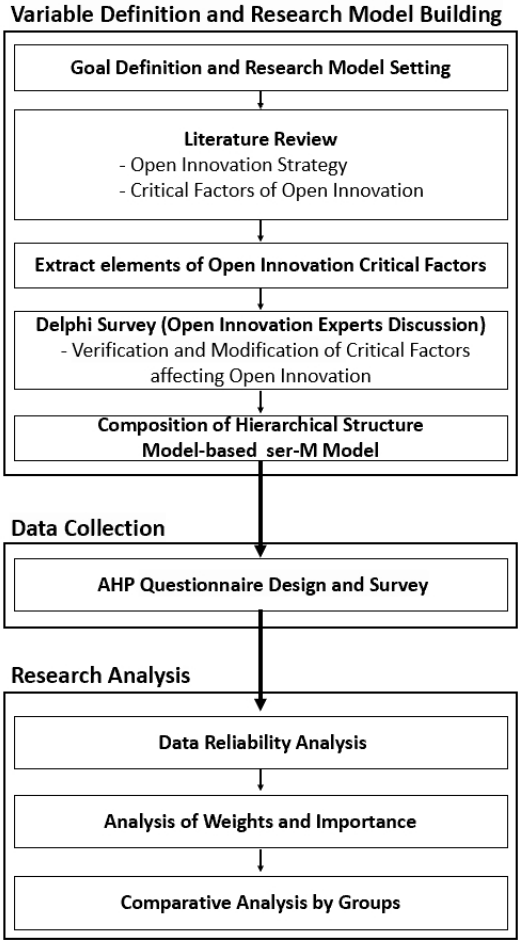


**Figure 2.** Research process.

A total of 5 experts were interviewed over the course of 3 days, from 12 June to 14 June 2024. The interviews yielded a total of 16 critical factors (evaluation factors). Based on these 16 factors, a research model for an AHP analysis was ultimately constructed. The research model was constructed based on the ser-M model, adopting a hierarchical structure centered on 4 major variables (evaluation areas): subject, environment, resources, and mechanism.

In the second step, the analytic hierarchy process (AHP) methodology was employed to evaluate and contrast the relative significance of the critical factors influencing structured open innovation strategies. Korean high-tech companies were divided into two comparison groups. The first was an engineer group, which included technical researchers in business units that execute open innovation projects in high-tech companies. The second was a professional support group, which included those who specialize in supporting companies' open innovation.

This included activities such as discovering new technologies and introducing them to R&D departments, building strategic partnerships, and making equity investments. The samples were composed of professionals with a minimum of 10 and a maximum of 25 years of experience in their business areas.

The survey was conducted via a one-to-one direct survey over a period of three weeks with 34 individuals, as arranged by the authors. Prior to distribution, the survey was pilot-tested with 10 individuals who work with the authors to ensure the accurate delivery and understanding of the survey content (see Appendix A). Moreover, we provided respondents with direct guidance on how to conduct the survey, ensuring that the survey's precise intention was accurately conveyed. The survey results were subsequently analyzed using Microsoft Excel, with only those within CR 0.1 being analyzed to guarantee reliability.

In the final stage of the analysis, the data obtained from the expert questionnaire were subjected to a mathematical process in order to determine the priorities and weightings among the evaluation areas. For the evaluation factors, the same evaluation area was used to calculate the priorities and weightings within the evaluation area (local) and among all evaluation factors, excluding the evaluation area (global).

### 3.2. Research Model

In this study, the ser-M model was applied and stratified to analyze the importance of the factors affecting the success of open innovation strategies. The ser-M model is a model based on mechanism theory, a dynamic theory of competitive strategy. It consists of four key factors of competitive strategy: subject, environment, resource, and mechanism.

Firstly, in terms of subjective factors, in order for an organization to gain and maintain a sustained competitive advantage, top executives and leaders must make decisions that are appropriate for a rapidly and constantly changing environment. Furthermore, it is essential for top executives and leaders to leverage and create the necessary resources in order to respond effectively to environmental changes (Porter 1991).

With respect to environmental factors, organizations operating within a rapidly evolving technological landscape, exemplified by the advent of artificial intelligence and computing, must adopt an adaptive strategy to ensure their sustained competitiveness and viability. This necessitates the integration of external resources and internal capabilities to navigate environmental shifts and maintain a competitive edge (Wang and Quan 2019). Furthermore, the expedient integration of cutting-edge technologies is essential to enhance resilience amidst changing conditions and to propel organizational performance (Dodgson et al. 2006).

Resource factors, such as absorptive capacity, financial support, and market knowledge, contribute to a firm's intrinsic competitiveness (Teece 2010; Laursen and Salter 2006; Zhang et al. 2023). The efficient utilization and support of these factors form the basis for the success of an open innovation strategy (Zincir and Rus 2019).

Finally, mechanism factors are sometimes classified as processes or routines depending on the researcher (Matt et al. 2015). They are defined as the process of integrating and reconfiguring capabilities inside and outside the organization to respond to rapidly changing environments (Reiss 2007; Christensen 1997). The competitive advantage of a firm can be affected by the organization and operation of the mechanisms in place (Cho 2014). In pursuing an open innovation strategy, mechanistic factors such as decision-making processes, the formation of external partnerships, and the establishment of a flexible organizational

structure are closely related to the performance of open innovation (Kuschel et al. 2011; Smith et al. 2008; Haefliger 2019).

As illustrated in Figure 3, the first-level evaluation areas for the success of the open innovation strategies of high-tech companies were defined as subject, environment, resource, and mechanism. Subsequently, 16 open innovation critical factors were classified into 4 categories based on the aforementioned first level. The operational definitions of each secondary critical factor are provided in Table 2.

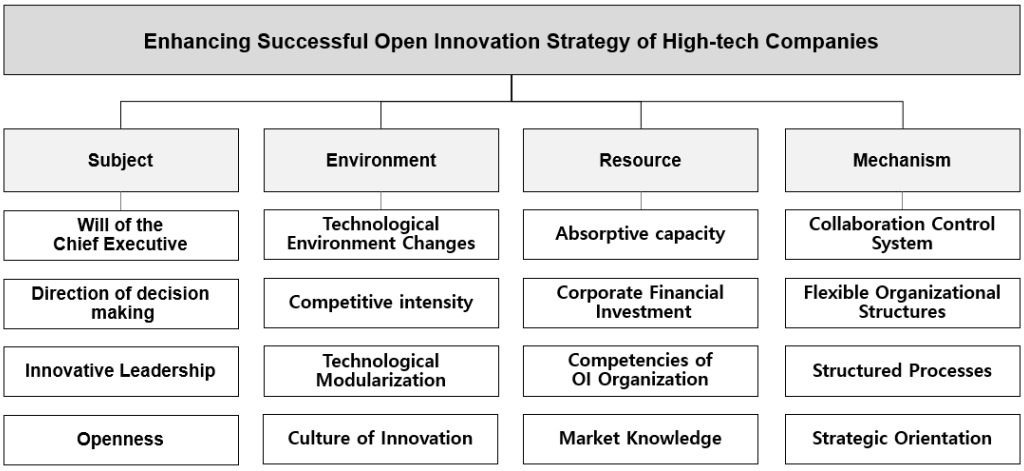


**Figure 3.** Research framework.

**Table 2.** Operational definitions of analysis variables.

| Evaluation Area | Evaluation Factor | Definition | Related Studies |
|---|---|---|---|
| Subject | Will of the Chief Executive | The establishment of a clear vision and active support from chief executives is essential for the effective implementation of open innovation processes. | Ahn et al. (2017); Bogers et al. (2019); Drechsler and Natter (2012); Enkel et al. (2011); Naqshbandi et al. (2019); Rumanti et al. (2021); Teece (2020) |
| | Direction of Decision-Making | The effective integration of external ideas and resources, coupled with the capacity to make innovative decisions that reflect diverse perspectives, is a crucial skill in any field. | |
| | Innovative Leadership | Leadership that cultivates a culture of creativity and innovation and that provides an environment conducive to the implementation of novel ideas. | |
| | Openness | The capacity to recognize and accept novel insights and experiences from external sources is a crucial aspect of organizational awareness and attitude. | |
| Environment | Technological Environment Changes | The evolution of R&D and market environments in response to new technological advancements and innovations. | Arora (2004); Gassmann et al. (2010); Keupp and Gassmann (2009); Lichtenthaler (2009); Ozman (2011); Sá et al. (2023); He and Liu (2011) |
| | Competitive Intensity | The degree of competition among companies in an industry and market and the extent to which competition exerts influence over operations. | |
| | Technological Modularization | An R&D approach that entails the independent design of system and product technology according to functional specifications, with the objective of facilitating interchangeability and reusability. | |
| | Culture of Innovation | The prevailing culture within the industry facilitates the adoption of external technology and knowledge, rather than the perpetuation of proprietary solutions. | |

**Table 2.** *Cont.*

| Evaluation Area | Evaluation Factor | Definition | Related Studies |
|---|---|---|---|
| Resource | Absorptive Capacity | The ability of an organization/individual to identify, assimilate, transform, and exploit knowledge from its environment. | Chesbrough (2006b); Cohen and Levinthal (1990); Hung and Chou (2013); Mirza et al. (2022); Miyao et al. (2022); Spithoven et al. (2011); West and Bogers (2014) |
| | Corporate Financial Investment | Corporate-level financial support to drive open innovation, such as CVCs and corporate funds. | |
| | Competencies of Open Innovation Organization | An organization's ability to strategically manage open innovation, collaborate with external partners, and integrate new ideas internally. | |
| | Market Knowledge | Information and knowledge about the market that are shared internally within the organization. | |
| Mechanism | Collaboration Control System | An organizational structure that enables different organizations to effectively collaborate and innovate during open innovation. | Carbone et al. (2010); Chesbrough (2007); Colombo et al. (2010); Cricelli et al. (2023); Dries et al. (2013); Gaspary et al. (2020); Haefliger (2019) |
| | Flexible Organizational Structures | A structure that enables an organization to respond quickly to changing environments and to capture and leverage innovative ideas from inside and outside the organization. | |
| | Structured Processes | A system for quickly responding to and systematically resolving problems in the execution of open innovation. | |
| | Strategic Orientation | The alignment of strategic behaviors and attitudes in an organization to achieve open innovation goals. | |

### *3.3. AHP Analysis*

In this study, we employed the analytic hierarchy process (AHP) to ascertain the relative importance and ranking of factors. The AHP is a multi-criteria decision-making method developed by Thomas L. Saaty (1972, 1980). It is a structured decision-making method that enables the optimal choice to be made among multiple alternatives or the decomposition of complex problems into a hierarchical structure, with the objective of determining priorities through a comparison of the factors in each hierarchy. The characteristics of an AHP analysis include the following: first, intuitive judgment is possible; second, relative importance can be clearly identified; third, errors can be prevented by consistency verification; and fourth, it is applicable to various fields (Robertsone and Lapiņa 2023).

The AHP analysis method is predicated on the identification of core factors, which are derived from the researcher's experience, knowledge, and intuition. The method entails the selection of two evaluation factors and the performance of a pairwise comparison. Subsequently, the eigenvalues and eigenvectors of the pairwise comparison metrics are calculated, and the relative importance is finally evaluated. Ultimately, the relative importance of all the evaluation factors is calculated by summarizing them. Typically, a 9-point scale is employed for a pairwise comparison (Udo 2000), and the analytical process of the AHP is illustrated in Figure 4.

In accordance with the criteria set forth by Harker and Vagras (1990), the AHP analysis procedure employs pairwise contrasts to assign equal importance to the contributions to the first factor on a 9-point scale. The pairwise contrasts between two factors ($\omega i$ and $\omega j$) are numbers arranged from 1 to 9 according to their relative preference or importance. The numbers are as follows: 1 is equal, 3 is slightly important, 5 is important, 7 is very important, and 9 is absolutely important. A number closer to 9 indicates a greater degree of importance for the factor in question.

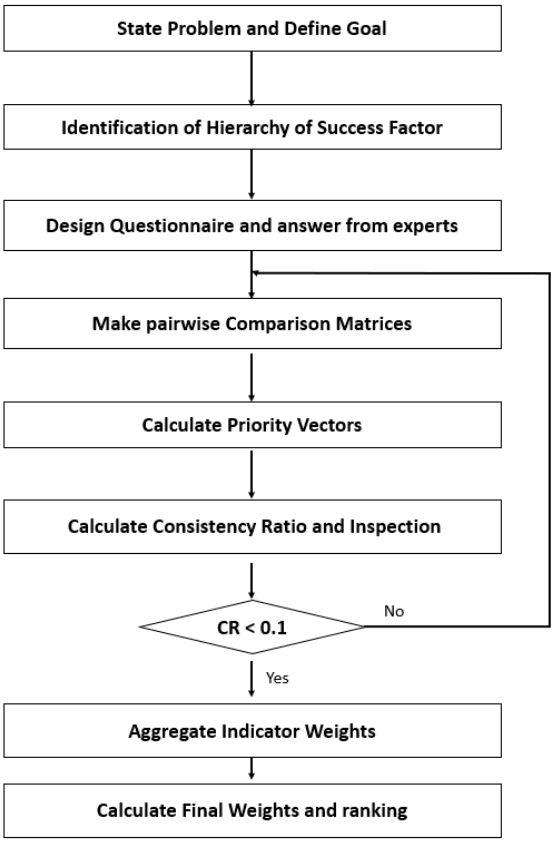


**Figure 4.** Process of AHP analysis.

In order to undertake a pairwise comparison of n alternatives for each criterion, it is necessary to perform $n(n-1)/2$ analyses. The resulting pairwise alternatives matrix, designated as A, assumes the form of an inverse centered on the square of the matrix, as illustrated below. This matrix represents the relative importance of each element. The ratio $\omega i/\omega j$ indicates the degree to which the i-th element is more important than the j-th element.

$$A = B \begin{bmatrix} 1 & \omega_1/\omega_2 & \cdots & \omega_1/\omega_n \\ \omega_2/\omega_1 & 1 & \cdots & \omega_2/\omega_n \\ \vdots & \vdots & 1 & \vdots \\ \omega_n/\omega_1 & \omega_n/\omega_2 & \cdots & 1 \end{bmatrix}$$

There are multiple methods for estimating importance, including the geometric mean and the arithmetic mean. However, we selected the geometric mean because it is more computationally complex than the arithmetic mean, yet it maintains proportional consistency and reduces the impact of extreme values. λ max (the maximum eigenvalue) is the largest of the eigenvalues of a pairwise comparison matrix. In an ideal situation, when a pairwise comparison matrix is completely consistent, the maximum eigenvalue (λ max) corresponds to the dimensionality of the matrix and is used to calculate the consistency index. The n × n square matrix [A] is multiplied by the n × 1 weight matrix [W], resulting in a new n × 1 weight vector matrix [Y]. This can be derived from the components $Y_1 \ldots Y_n$ and the weights $W_1 \ldots W_n$. The aforementioned concept can be expressed as a formula:

$$[a] \times [w] = [y]$$

$$\lambda \text{ max} = \frac{Y1/W1 + Y2/W2 + ... + +Yn/Wn}{n}$$

The consistency of the surveyed respondents is evaluated through the consistency ratio (CR), which is the ratio of the consistency index (CI) to the random index, determined by the size of each matrix. The consistency ratio demonstrates the extent to which the consistency of the surveyed respondents differs from that of a random sample of respondents. The consistency index is defined as follows:

$$\mathrm{CI} = \frac{\lambda\mathrm{max} - n}{n-1} \quad \mathrm{CR} = \frac{CI}{RI} \times 100(\%)$$

$$\lambda \text{ max} \geq \text{n (n = dimension of matrix)}$$

### *3.4. Data Collection and Process*

It is crucial to consider the demographic profile of the respondents in order to gain insight into the relative importance of open innovation success factors, which represents the primary objective of this study. A total of 30 professionals with a minimum of a decade of pertinent work experience in the field were surveyed, comprising 15 engineers with a strong understanding and experience of open innovation and 15 experts from open innovation support groups.

Previous studies (Abastante et al. 2019; Munier and Hontoria 2021) have revealed that the AHP method targets a group of experts with more than 10 years of experience in decision-making, so even a small group of 10 or more people can have reliability in the analysis results. Based on these preceding studies, this study also selected more than 15 people for each group with relevant expertise and knowledge, decision-making experience, or influence.

The respondents were employees of global high-tech companies in Korea, the United States, Japan, and Europe. They represent a diverse range of business divisions, including semiconductors, displays, cell phones, and research centers. The respondents possess expertise in a range of fields, including electronics, communications, displays, and machinery. They occupy various positions within the organizational hierarchy, from team members to executives, reflecting the diverse roles and perspectives they bring to the workplace. The survey participants' experience, job functions, and positions are detailed in Table 3.

**Table 3.** Demographic information of respondents.

| Section | | Sample Size | % |
|---|---|---|---|
| Gender | Male | 27 | 90 |
| | Female | 3 | 10 |
| Age | 30s | 2 | 7 |
| | 40s | 15 | 50 |
| | 50s | 13 | 43 |
| Job Experience | 10–20 Years | 7 | 23 |
| | 20–30 Years | 19 | 63 |
| | 30 Years | 4 | 13 |
| Job Area | Engineers | 15 | 50 |
| | Open Innovation Professionals | 15 | 50 |
| Position | Team Member | 3 | 10 |
| | Director | 19 | 63 |
| | Executive | 8 | 27 |

Accordingly, the survey group was divided into two categories: the "engineer group" and the "professional support group". The engineer group was defined as researchers and developers tasked with new technology R&D in business units within advanced technology companies who are responsible for implementing open innovation strategies. The professional support group was defined as personnel engaged in the discovery of new technologies who collaborate with R&D personnel to establish strategic partnerships

and equity investments. Subsequently, a comparative analysis was conducted to ascertain the differences in the perceived importance of factors according to the aforementioned job characteristics.

The survey scale was constructed in accordance with Podvezko's (2009) guidelines for designing AHP questionnaires, employing a bi-directional 1–9-point scale. In-person surveys were conducted, and comprehensive instructions were provided in advance to ensure that the respondents could respond to the questions with an accurate understanding of the context and critical factors. The survey was conducted via one-on-one interviews over a three-week period between 24 June and 12 July 2024. A total of 34 responses were collected, and 30 were ultimately deemed suitable for analysis, with 4 responses excluded due to inconsistencies.

The Microsoft Excel software, version 2019, was used to conduct the analysis. To ensure the reliability of the questionnaire responses, only responses within the 95% confidence interval were analyzed. Table 3 summarizes the distribution of the survey subjects.

## 4. Results

### *4.1. Comparison of Evaluation Variables*

The results of the critical factor analysis of open innovation in high-tech companies, as presented in Table 4, represent the findings of the overall AHP analysis. The weights and priorities of each factor are presented. Local weights are the weights and priorities measured between each sub-area factor. Global weights are the weights and priorities measured across all sub-areas. Critical factors are the weights and priorities measured across all sub-areas. In this context, the term "global weights" refers to the weights and priorities that were calculated on the basis of all sub-regions.

As illustrated in Table 4, the most significant factor within the evaluation domain was subject, with a weight of 0.556. Subsequently, the domains environment (0.263), resource (0.121), and mechanism (0.060) were identified as the next most important in descending order. These findings substantiate the assertion that the roles of the CEO and other leaders are of paramount importance in the success of open innovation in high-tech companies.

In terms of evaluation area, the subject domain was rated the highest for the will of chief executives (0.373), and direction of decision-making (0.370) was rated similarly, followed by innovation leadership (0.184) and openness (0.073). In particular, the characteristic factors of the subject, such as leadership and openness, showed much lower importance than the will and decision-making direction. In the end, it was confirmed that the activity factor had a greater influence on open innovation than the characteristic factor of the subject.

In the environment domain, the factor of technological environment change was rated as being of greater importance than the other factors, with a rating of 0.560. Subsequently, competitive intensity (0.262), technological modularization (0.112), and culture of innovation (0.067) were identified as the next most important factors. This shows the significant impact of technology environment change on open innovation strategy. The relatively very low importance of technology modularity and innovation culture factors eventually shows that external environmental factors have a more important influence on open innovation than internal environmental factors.

In the resource domain, the highest rating was given to absorptive capacity (0.569), followed by corporate financial investment (0.241), competencies of open innovation organization (0.118), and market knowledge (0.067). According to the results of this study, the ability of a company to integrate various external knowledge and ideas is considered a key factor in determining the success of open innovation. In particular, market knowledge showed a very low level of importance. This shows that factors such as competency or investment that directly affect open innovation strategy are much more important than indirect influencing factors such as knowledge or information.

**Table 4.** Weights and priority of evaluation variables.

| Evaluation Areas | The Weights of Areas | Evaluation Factors | The Weights of Evaluation Factors | | | |
|---|---|---|---|---|---|---|
| | Local | | Local * | Priority | Global ** | Priority |
| Subject | 0.556 | Will of Chief Executives | 0.373 | 1 | 0.207 | 1 |
| | | Direction of Decision-Making | 0.370 | 2 | 0.205 | 2 |
| | | Innovation Leadership | 0.184 | 3 | 0.102 | 4 |
| | | Openness | 0.073 | 4 | 0.041 | 7 |
| Environment | 0.263 | Technological Environment Changes | 0.560 | 1 | 0.147 | 3 |
| | | Competitive Intensity | 0.262 | 2 | 0.069 | 6 |
| | | Technological Modularization | 0.112 | 3 | 0.029 | 8 |
| | | Culture of Innovation | 0.067 | 4 | 0.018 | 12 |
| Resource | 0.121 | Absorptive Capacity | 0.569 | 1 | 0.069 | 5 |
| | | Corporate Financial Investment | 0.241 | 2 | 0.029 | 9 |
| | | Competencies of Open Innovation Organization | 0.118 | 3 | 0.014 | 13 |
| | | Market Knowledge | 0.071 | 4 | 0.009 | 14 |
| Mechanism | 0.060 | Collaboration Control System | 0.475 | 1 | 0.029 | 10 |
| | | Flexible Organizational Structure | 0.306 | 2 | 0.018 | 11 |
| | | Structured Processes | 0.135 | 3 | 0.008 | 15 |
| | | Strategic Orientation | 0.084 | 4 | 0.005 | 16 |
| Total | 1.000 | | 4.000 | | 1.000 | |

* Local: mean value of the evaluation factors in each group of criteria. ** Global: mean value of evaluation factors in total criteria.

Finally, in the mechanism domain, the factor collaboration control systems (0.475) was rated as more important than the other factors, followed by flexible organizational structure (0.306), structured processes (0.135), and strategic orientation (0.084). In particular, strategic orientation showed relatively very low importance, which shows that real-world behavioral factors such as systems, processes, and structures are more important than strategy or goal setting in the open innovation strategy.

Furthermore, the evaluation factor analysis, which examined the overall ranking reflecting each factor in each evaluation area, demonstrated that "will of chief executives (0.207)" exhibited the highest value, followed by "direction of decision-making (0.205)", "technological environment changes (0.147)", and "innovative leadership (0.102)." The least important factors were strategic orientation (0.005) and structured processes (0.008), which were ranked 16th and 15th, respectively.

### *4.2. Comparison of Evaluation Areas Between Business Group and Professional Group*

A comparison of the surveys completed by the engineer group and the professional support group revealed slight discrepancies in the weights assigned to the two groups with regard to the evaluation areas. However, the results were consistent, with subject, environment, resources, and mechanisms emerging as the primary factors. As illustrated in Table 5 and Figure 5, the ranking of evaluation factors exhibited a similar consistency between the two groups, mirroring the patterns observed in the evaluation areas. Ultimately, the engineer group and the professional support group identified the most critical factors

for implementing an open innovation strategy as "will of chief executives", "direction of decision-making", "technological environment change", and "innovative leadership".

**Table 5.** Comparison analysis results of evaluation factors.

| Evaluation Factors | Weights of Evaluation Factors | | | | Priority of Factors (by Global) | |
|---|---|---|---|---|---|---|
| | Local | | Global | | | |
| | Engineer Group | Professional Support Group | Engineer Group | Professional Support Group | Engineer Group | Professional Support Group |
| Will of Chief Executives | 0.362 | 0.370 | 0.205 | 0.203 | 2 | 2 |
| Direction of Decision-Making | 0.389 | 0.372 | 0.220 | 0.205 | 1 | 1 |
| Innovation Leadership | 0.177 | 0.172 | 0.100 | 0.094 | 4 | 4 |
| Openness | 0.072 | 0.086 | 0.041 | 0.047 | 7 | 7 |
| Technological Environment Changes | 0.577 | 0.548 | 0.152 | 0.143 | 3 | 3 |
| Competitive Intensity | 0.249 | 0.280 | 0.066 | 0.073 | 5 | 5 |
| Technological Modularization | 0.107 | 0.110 | 0.028 | 0.029 | 9 | 10 |
| Culture of Innovation | 0.066 | 0.062 | 0.017 | 0.016 | 12 | 12 |
| Absorptive Capacity | 0.578 | 0.566 | 0.065 | 0.072 | 6 | 6 |
| Corporate Financial Investment | 0.237 | 0.244 | 0.027 | 0.031 | 10 | 8 |
| Competencies of Open Innovation Organization | 0.127 | 0.104 | 0.014 | 0.013 | 13 | 13 |
| Market Knowledge | 0.058 | 0.087 | 0.006 | 0.011 | 15 | 14 |
| Collaboration Control System | 0.472 | 0.495 | 0.028 | 0.031 | 8 | 9 |
| Flexible Organizational Structure | 0.297 | 0.295 | 0.018 | 0.018 | 11 | 11 |
| Structured Processes | 0.123 | 0.140 | 0.007 | 0.009 | 14 | 15 |
| Strategic Orientation | 0.108 | 0.069 | 0.006 | 0.004 | 16 | 16 |
| Total | 4.000 | 4.00 | 1.000 | 1.000 | | |

The factors that exhibited discrepancy were technological modularization, corporate financial investment, market knowledge, and structured processes. The engineer group, which is responsible for the actual R&D, placed relatively more importance and priority on the collaboration control system (0.028), technological modularity (0.028) and structured processes (0.007). This suggests that engineers engaged in R&D consider well-designed processes, a collaborative management system involving partners, and technology modularization driven by digitalization to be significant factors.

In contrast, the professional support group, which is responsible for identifying potential companies and evaluating and executing investments, placed more importance and priority on corporate financial investment (0.031) and market knowledge (0.011) than the engineer group. This is because professional support groups are required to establish strategic partnerships with prospective partners, such as mergers and acquisitions (M&A) and equity investments, and to evaluate the market impact of their collaboration with these partners (see the highlighted section in Figure 5).

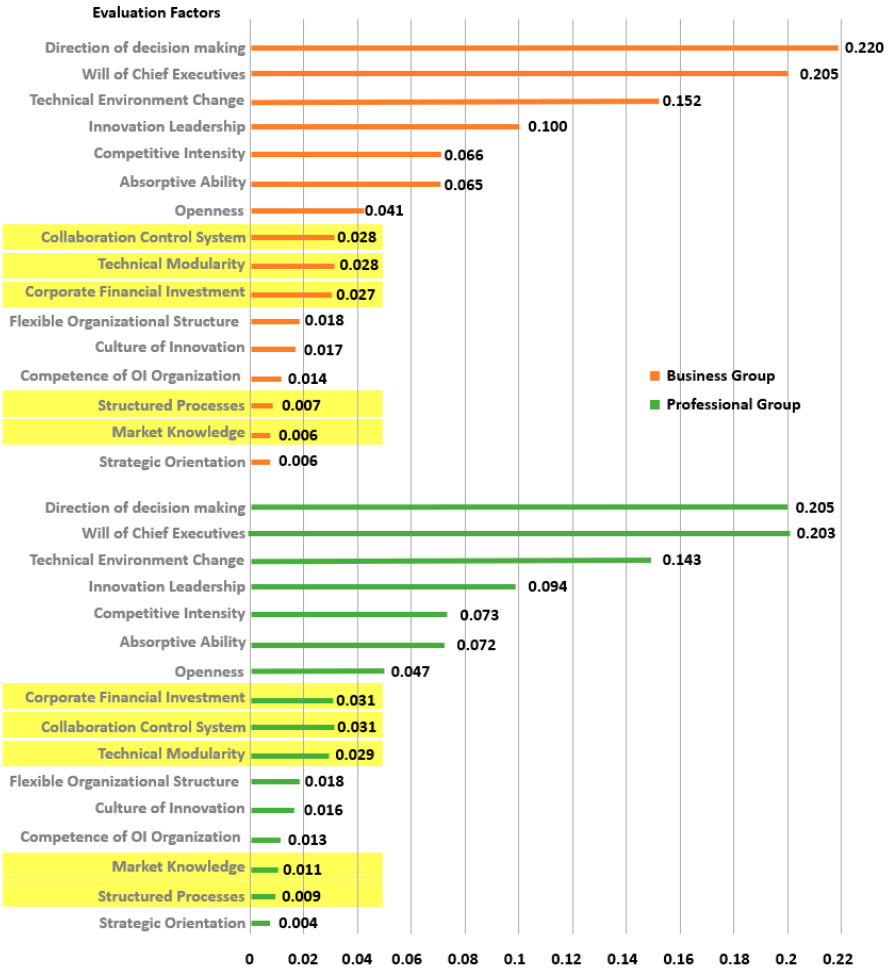


**Figure 5.** Comparison between business group and professional group.

This corroborates the hypothesis that the professional support group places a greater emphasis on the role of planning and finance in the execution of open innovation projects, whereas the engineer group deems the development aspects of technology applicability and the process operations of innovation challenges to be of greater consequence.

## 5. Discussions

In order to define the factors that influence the success of open innovation in high-tech companies, this study designed a research model based on the ser-M model, which consists of subject, environment, resources, and mechanisms. The relative importance of the factors was then evaluated through an analytic hierarchy process (AHP) analysis of four evaluation areas and 16 evaluation factors. The analysis yielded the following key findings.

Firstly, both the engineer group and the professional support group rated the importance of the evaluation areas to the success of open innovation the same: subject, environment, and resources. The importance of each dimension did not differ significantly between the groups. This indicates that the role of subject, including the will of chief executives and direction of decision-making, is the most important factor in the success of open innovation, followed by the environment, resources, and mechanism domains.

The fact that subject was the most important factor suggests that the will of chief executives, direction of decision-making, and leadership for innovation play the most central and decisive roles in driving open innovation. As Chesbrough (2006b) posited, the adoption of an open innovation strategy inherently entails a certain degree of risk. The success of an open innovation strategy is only possible when the leadership of the

organization, led by top management, makes appropriate substitutions and decisions on the risks involved in open innovation.

During the adoption and activation phases of an open innovation strategy, which are heavily influenced by the decisions of the key subject, the importance of top management cannot be underestimated (Salter et al. 2014; Lu et al. 2022). Ultimately, given the nature of high-tech firms, where the development and acquisition of core technologies are critical to the firm's continued growth and innovation, the commitment to an open innovation strategy by top management, who lead corporate strategy and technology development, as well as the decision-making that can continue to drive and support it, can make or break an open innovation strategy and influence firm performance.

However, in contrast to previous studies that previously emphasized the importance of leadership or openness in digital transformation or open innovation strategies, this study found that leadership and openness were relatively insignificant. In the end, it can be seen that factors such as willingness to drive direct action and decision-making are important in promoting open innovation strategies.

Secondly, the findings of our research demonstrate the significance of technological environmental change factors. In order for high-tech companies to successfully implement an open innovation strategy, it is essential that they possess the ability to perceive and respond to rapidly evolving environments in a more agile manner than their competitors. This is particularly crucial for companies operating within highly competitive markets. Lichtenthaler (2009) posits that organizations that proactively integrate external technologies in response to a rapidly evolving technological landscape are more likely to exhibit enhanced performance outcomes. Conversely, Arora (2004) contends that solely relying on internal technologies may prove inadequate in a volatile technological environment.

The company investigated in this study is engaged in the high-tech industry, which is typified by rapidly evolving technological and market environments and intense competition among firms in diverse nations. The findings of the analysis are entirely consistent with these characteristics. The ubiquity and modularization of technology, especially in high-tech industries, suggest the importance of the environment for the success of open innovation strategies for companies operating in high-tech areas.

Nevertheless, as Dahlander and Gann (2010) argued, these factors should be considered differently by country, region, and company size, and effectiveness in open innovation can be maximized by reducing external activities and focusing on core businesses in the short term. Therefore, it is important to set strategic directions that take into account the external and internal technology environment, depending on the conditions of the industry and the business environment.

Thirdly, our findings indicate that a firm's or organization's absorptive capacity has a considerable influence on its performance in order for an open innovation strategy to be successful. The success of an open innovation strategy hinges on the establishment of a robust knowledge base to ascertain the suitability and caliber of external technologies (Ahn et al. 2018). Given that knowledge gaps impede a firm's openness (Drechsler and Natter 2012), it is imperative to cultivate absorptive capacity through knowledge building (Lichtenthaler and Lichtenthaler 2009). The extent to which a company can internalize and drive performance is contingent upon its absorptive capacity, which, in turn, is directly related to whether and how successful open innovation is (Spithoven et al. 2011).

However, as Hung and Chou (2013) and Audretsch and Belitski (2023) mentioned, it may be important to develop internal technologies that can lead to open innovation as much as absorption capacity. Open innovation is not only aimed at absorbing external technologies and knowledge but also plays a role in maximizing internal technologies and capabilities by networking with external ecosystems. Therefore, for high-tech companies, it is necessary to lead various forms of open innovation by continuously leading internal technology development beyond the open innovation strategy that focuses on utilizing external technologies.

In the case of open innovation that accepts external technology, the company's unique ability to absorb external technology, which is the ability of a company to convert technology imported from outside into assets, should be supported (Cohen and Levinthal 1990). In addition, closed innovation, in which a company strives to innovate technology through internal R&D, may be better for a company's competitiveness than open innovation, as it is protected by intellectual property for the outcome of technological innovation, and the company has ownership of the technology. Therefore, it is necessary for companies to secure their own technologies and capabilities, and for parts that cannot be achieved by themselves, it is necessary to find solutions through external cooperation.

## 6. Conclusions

### *6.1. Implications*

Currently, digital transformation is taking place everywhere, including in industries, and it is led by ultra-large AI and big data technology. With the advancement of technological progress, open innovation strategies have emerged as an alternative for sustainable survival in today's era when boundaries between industries have collapsed and the speed and composition of competition have changed. Open innovation refers to creating new values by organically combining ideas and experiences inside and outside an organization (Robertsone and Lapiņa 2023).

It is a method of utilizing technology, knowledge, and various resources, including ideas. With the collapse of manufacturing, production, and service methods like those from the past, it is now difficult to secure a competitive advantage by relying only on existing original technology and creativity. In other words, it can be said that the closed management model that relied only on the internal knowledge and technology of an organization has reached its limit. Now, it is necessary to accept knowledge and skills from external networks by utilizing knowledge diversity rather than monopolies on knowledge.

In this environment, over the past 20 years, open innovation strategies have emerged as the dominant approach to innovation for technology-based companies. Moreover, as digital technology advances, technological collaboration and open innovation between companies continue to accelerate. Nevertheless, studies on internalization and efficient operation of open innovation strategies in terms of organizations, resource management, and processes are lacking compared to studies that have proven their effectiveness in R&D or new product development.

In this regard, this study is meaningful in that it empirically investigated and analyzed the key factors of the open innovation strategy of high-tech companies that have been pursuing open innovation strategies for more than a decade in various aspects, including topics, resources, environment, and mechanisms.

In terms of practical implications, the most significant factor influencing the success of an open innovation strategy is the leadership of the highest levels of management, including a robust commitment to innovation and decision-making. It is imperative that top executives possess a comprehensive understanding of the rationale behind the necessity of open innovation for their organization. They should use this understanding to set the strategic direction of the organization and guide their decision-making. It is imperative that the rationale espoused by executives be explicitly delineated in the corporate strategy and business plan. Furthermore, an explicit buy-in process must be established and disseminated throughout the organization to ensure uniform understanding and alignment.

Furthermore, a consensus-building effort with line and middle managers is necessary to ensure that open innovation activities align with the commitment of the C-suite. A strategy that is not known or understood by all members of an organization cannot ensure consistency and direction and is therefore devoid of meaning as a corporate strategy.

Secondly, it is incumbent upon companies and their members to maintain the vigilant and continuous monitoring of rapidly evolving technology trends and market changes. They must also develop the absorptive capacity to effectively internalize these changes and strive to cultivate a flexible innovation culture that enables them to seamlessly integrate internal and external resources. In other words, members of companies must develop the capabilities required for open innovation. First and foremost, they must possess the internal capacity to read and evaluate rapidly changing global trends in technology and industry. It is essential that a systematic and organized system be in place for the exploration of which laboratories and companies possess such technologies.

Such readily available capabilities will serve as a differentiating factor for a company that is able to accurately and rapidly assimilate external knowledge and ideas, thereby driving internal innovation. It is imperative that researchers establish an organizational culture that is receptive to novel concepts and perspectives, eschewing the tendency towards insularity and an exclusive focus on in-house development.

Thirdly, companies must provide the necessary financial, human, and organizational resources to enable their personnel to focus on open innovation. When internal researchers proactively engage with external ideas to generate novel outcomes, it is essential to cultivate a culture of innovation that equitably acknowledges and rewards these outcomes on par with those of internal development. Institutional arrangements need to be in place to thoroughly analyze the cost of internal R&D versus the cost of R&D through open innovation so that financial investments can be made in a timely manner when needed.

A dedicated organization that can professionally run and manage these efforts is critical to accelerating an open innovation strategy. Good ideas and technologies from outside an organization do not wait around and are ready to be shared with other organizations at any time. As a result, organizations need to ensure that they have the resources in place to identify, evaluate, and collaborate on innovative ideas.

It is imperative that companies implement a systematic approach to ensure that open innovation activities are driven by a continuous and coherent process that transcends the influence of a few individuals, such as the top management team.

Fourthly, although the role of top executives is pivotal to the success of an open innovation strategy, it is imperative that they act as a catalyst for innovation rather than as the sole drivers of the process. The composition of an organization's leadership can be subject to change at any given moment, and the accessibility of resources, such as personnel and financial capital, can fluctuate in accordance with the specific characteristics of the industry and the prevailing business environment. Furthermore, a multitude of promising technologies may emerge concurrently. A comprehensive examination of the significance of individual projects and items is essential to guarantee an optimal distribution of internal and external resources, thereby enhancing the efficacy of open innovation.

Given the constraints on corporate resources, such as human and financial resources, it is essential to conduct a systematic analysis of the value of external knowledge in order to prioritize its selection and focus. The decision-making body may vary depending on the importance and scale of the case, but the distribution of the decision-making authority should also be considered to ensure the efficient and expedient promotion of open innovation.

In order to facilitate the implementation of open innovation activities within an enterprise, it is necessary to establish a system and a gating process that allows employees to promote open innovation in a natural and iterative manner, in accordance with the established system and organizational rules. The efficacy of an open innovation strategy is contingent upon the strategic orientation and systematic movements of all members of the enterprise.

Ultimately, while this research is focused on the success factors of open innovation in high-tech companies, it can also inform innovation in the public sector, as evidenced by Astra Zeneca's approach during the pandemic. Collaboration between public and private companies has the potential to result in improvements to the quality of public services and infrastructure.

Furthermore, it can facilitate the creation of innovative solutions that are tailored to public needs in areas such as smart cities and healthcare systems. Public innovation can be promoted through the exchange of data and knowledge between companies. Public organizations may also adopt technologies from private companies to enhance the quality of public services and address social issues more effectively.

Private companies can benefit from open innovation with public organizations by reducing R&D costs and securing business opportunities in public markets. Open innovation by enterprises can be utilized as a valuable strategic tool for public innovation, and the innovation results can facilitate public innovation and contribute to improving the quality of public services and creating social value.

### *6.2. Research Limitations and Future Plans*

The following limitations of this study can be addressed in future studies: First, this study focuses on high-tech companies that have implemented open innovation strategies. Unlike the general technology-based manufacturing industry, there is a limit to the generalization of the research results, as they reflect the specificity of high-tech companies. Therefore, future research needs to expand research on various technology-based companies. In addition, it is possible to consider studies comparing differences in open innovation strategies that appear between manufacturing companies and service companies in the consideration of technology-based manufacturing as well as service industries.

Second, this study has a regional limitation, in that it conducted its research on open innovation experts in Korea. Therefore, in future studies, it will be necessary to consider expanding research on expert groups to other major countries and continents.

Finally, there is a limitation of this study, in that the dynamic connection and correlation between the derived factors were not considered in this study. Considering the evolving nature of open innovation strategies that are adopted in the maturity stage and that are vulnerable to environmental changes, future research will be able to conduct research on open port innovation strategies based on the relationship between factors by considering the temporal and dynamic connectivity between important factors.

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**Data Availability Statement:** Data are not publicly available due to the privacy of the respondents.

**Conflicts of Interest:** The authors declare no conflicts of interest.

## Appendix A. Sample of the Questionnaire

Part A. Evaluation criteria importance rating

**A0.** First, to ensure consistent responses to the AHP questionnaire, please list the following four evaluation criteria (Subjective, Environmental, Resource, and Mechanism aspects) in order of relative importance.

1st( ) > 2nd( ) > 3rd( ) > 4th( )

| | |
|---|---|
| Subjective aspects | The importance of ownership, including top management commitment, decision direction, innovative leadership, and openness |
| Environmental aspects | Environmental significance, such as changing technology landscape, competitive intensity, technology modularization, etc. |
| Resource aspects | Resource significance, such as absorption ability, financial investment, dedicated organizational capacity, etc |
| Mechanism aspects | Mechanistic importance, such as collaborative control systems, flexible organizational structure, strategic orientation, etc. |

**A1.** In your opinion, which of following criteria, item A or item B, is more important in assessing the impact of open innovation success in technology-driven companies?

**Check the box (O, V, etc.) for the more important of the two factors on either side, based on a value of 1 in the center.**

| No | Item A | ←—— Importance ——→ | | | | | | | | | | | | | | | | Item B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| 1 | Subjective aspects | | | | | | | | | | | | | | | | | | Environmental aspects |
| 2 | Subjective aspects | | | | | | | | | | | | | | | | | | Resource aspects |
| 3 | Subjective aspects | | | | | | | | | | | | | | | | | | Mechanism aspects |
| 4 | Environmental aspects | | | | | | | | | | | | | | | | | | Resource aspects |
| 5 | Environmental aspects | | | | | | | | | | | | | | | | | | Mechanism aspects |
| 6 | Resource aspects | | | | | | | | | | | | | | | | | | Mechanism aspects |

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