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Article

The role of innovation ecosystem in an open innovation model of state-owned enterprises to build collaborative advantage

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Abstract: State-owned enterprises (SOEs) manage significant portion of world economy, including in the developing countries. SOEs are expected to be active and play significant role in improving the country's economic performance and welfare through enhancing innovation performance. However, closed innovation process and lack of collaboration hinders SOEs to reach satisfying innovation performance level. This paper explores the construction and role of innovation ecosystem in the strategic entrepreneurship process of SOEs, of which is represented by dynamic capability framework, business model innovation, and collaborative advantage. Based on the analysis, this paper concluded that the collaboration between actors in the Innovation Ecosystem (IE) has positive effect to strengthening SOE's Sensing Capabilities (SC) related to the process of exploring and identifying innovation opportunities. The increase of Sensing Capabilities (SC) will play significant role as input or antecedent on formulating proactive Innovation Strategy (IS) in orchestrating SOE's innovation process. SOEs which has implementing proactive Innovation Strategy (IS) will be able to build collaboration and finding right Business Model Innovation (BMI). Finally, by building collaboration with other actors through the innovative business model has significant role to increase SOE's Collaborative Advantage (CA), which considered as a proxy for competitiveness of SOEs.

Keywords: collaborative innovation; collaborative advantage; dynamic capability; innovation ecosystem; open innovation; strategic entrepreneurship; state-owned enterprises; resource orchestration

1. Introduction

State-owned enterprises (SOEs) are always considered to have a significant contribution to the world economy, including in developing countries. These enterprises, being wholly or partially owned and operated by the government, often involved in various sectors such as financial, property, transportation, telecommunications and others. The existence of SOEs is deemed essential because SOEs can contribute greatly to gross domestic product (GDP), employment and market capitalization in developing countries (Organisation for Economic Co-operation and Development (OECD), 2015). It contributes approximately 10% of the world's GDP (Peng et al., 2016). Therefore, competitiveness of SOEs is significant aspect of a nation's economy.

One of the breakthrough efforts to develop SOEs competitiveness is through an effective innovation process. Innovation is an important tool for entrepreneurs as well as to develop country competitiveness and welfare (Drucker, 1985; Porter, 1990, 2001). Globalization, competitive market environment and disruptive technology eventually affecting innovation process to be more challenging, complex and costly.

Innovation has been considered the source of SOEs performance, growth, and competitiveness. It is considered as an essential factor for organizational construction and strategic maintenance, and key driver for its growth and sustainable competitive advantage in the competitive market (Drucker, 1955; Fontana, 2011; Tucker, 2003; Yun and Liu, 2019). Economy growth as a parameter of country performance is the dependent variable as the result of its national innovation capacity.

Open innovation paradigm paves way to explore innovation beyond their own internal environment (Chesbrough, 2003). Firms at any industries nowadays seek new form of synergy, partnership and collaboration in other to develop innovative business model and competitive advantage (Linde et al., 2021). Collaboration and alliances have become a trend in enabling long-term business growth. SOEs needs a systematic way in adapting and orchestrating their innovation processes in the context of innovation ecosystem to build competitive advantage through collaborative advantage in the midst of dynamic and complex environment. The government, industry, and universities play a significant role in creating and maintaining the nation's competitive advantage through the innovation and commercialization of new products (Farinha et al., 2014; Kelley et al., 2010).

In recent years, both academics and practitioners have shown increased interest in the concept of ecosystems as a new way to describe the competitive environment (Linde et al., 2021). Currently, no company is capable of conducting all its innovation activities alone, and even at the national level, no entity possesses all types of industries. Therefore, innovation gradually becomes a collective effort involving business actors from various companies, industries, and countries. Rapid technological advancements, digitalization, and the circular economy are driving industrial convergence and large-scale industrial transformation. This compels companies to become more dynamic, agile, fast, and open in their innovation endeavours. Digitalization and technological advancements are driving the expansion of the innovation concept into something more macro and through various forms of partnerships, termed innovation ecosystems (Adner, 2017).

In line with these trends, the current innovation competition among businesses is gradually evolving into competition among ecosystems (Adner and Kapoor, 2010). This trend needs to be understood by state-owned enterprises so that they not only consider the growth of their own companies but also how their ecosystems can develop. The term ecosystem has been used in the field of strategy for some time, and its application has also rapidly evolved over the last decade. Teece (2016) even suggests that the ecosystem concept may replace the industry concept in business analysis. Companies within an ecosystem rely on each other's contributions to a higher degree than the traditional value chain where suppliers can be more easily replaced (Adner, 2017; Jacobides et al., 2018).

An innovation ecosystem itself can be defined as a collaborative arrangement that is a combination of organizations and individuals offering solutions to customers (Adner, 2006). Autio and Thomas (2014) further define innovation ecosystems as interconnected networks of organizations or business actors, linked to focal companies capable of creating new value, with the following interaction characteristics: (i) more complexity in their organization, (ii) business/entrepreneurial in nature, (iii) emphasizing complex environmental conditions, (iv) open innovation-oriented, and (v)

experience-based (Rinkinen and Harmaakorpi, 2016). From the perspective of innovation ecosystems, companies need to be supported by technological advancements and actions from their complementors to succeed in innovation or realize their value proposition (Adner and Kapoor, 2010). Innovation ecosystems represent a form of open innovation process that encompasses research and development functions and various elements outside the organization. Innovation ecosystems consist of the focal firm (in this study, SOEs), its network of suppliers and customers, as well as complementors (Adner and Kapoor, 2010). Innovation ecosystems also describe the interdependent relationships among various innovation and technology actors, emphasizing their modularity and complementarities (Jacobides et al., 2018). Helman (2020) also developed an innovation system model evolution that has been tailored to market needs, consisting of several stages ranging from clusters, networks, triple- and quadruple-helix models, ultimately reaching the innovation ecosystem.

In the global North, innovation ecosystem tend to be anchored by large, well-established corporations and research universities, which provide the financial resources, technical expertise, and market access needed to commercialieze new technologies (Dudin et al., 2014). The innovation practices of state-owned enterprises in advanced countries can also be seen from the research conducted by Benassi and Landoni (2018), which discusses the role of SOEs in the innovation process within the context of developed countries. This research shows that SOEs play a crucial role in enhancing the effectiveness of innovation processes in companies within those countries. They use two case studies of SOEs in Europe—STMicroelectronics and Thales Alenia Space—to illustrate how SOEs can contribute to innovation by exploring new applications and market opportunities. The study of open innovation implementation conducted at SOEs in Russia by Gershman et al. (2019) also found that through open innovation initiatives, the four largest SOEs in Russia could actively engage in driving technology demand through strategic partnerships and collaborations, thereby fostering technological development and company performance. This research analyzes the emergence and practices of open innovation activities in Russian state-owned enterprises (SOEs) in comparison to the private sector. The study uses case studies of four Russian SOEs: Aeroflot (airline), Alrosa (mining), Rostec (civil and military products), and Rosatom (nuclear energy). These ecosystem often benefit from strong intellectual property rights, well-developed infrastructure, collaboration culture and highly skilled labor pools—factors that can facilitate rapid innovation and global market penetration.

In contrast, innovation ecosystems in the global South may be characterized by a predominance of small and medium-sized enterprises, informal sector activity, and less mature institutions for research, development, and commercialization(Abreu, 2021; Radziwon and Bogers, 2019; Schmitt et al., 2018). As a result, these ecosystems may face challenges in accessing the necessary capital, talent, and market linkages to drive transformative innovation (Martin et al., 2018; Schmitt et al., 2018). Nevertheless, the global South is home to numerous examples of vibrant innovation ecosystems that have leveraged local advantages to drive economic and social development. For instance, the emergence of mobile payment systems in East Africa, the rapid growth of the tech startup scene in India, and the development of frugal

innovations in China all point to the innovative capabilities that can exist in the global South.

Indonesia, as a prominent member of the Brazil, Russia, India, China, and South Africa (BRICS) group of emerging economies, has been undergoing a transformation in its innovation ecosystem. Recent studies have highlighted several key factors that shape the dynamics of innovation in Indonesia (Cirera et al., 2021; Harsanto et al., 2018; Muljono et al., 2021). First, there is a growing recognition among Indonesian firms of the importance of integrating sustainability considerations into their innovation activities, a concept known as sustainability-oriented innovation. Interviews with Indonesian business owners and managers reveal an increasing awareness of the need to balance economic, environmental, and social impacts in their innovation efforts. Second, the Indonesian government has identified the development of science and technology parks as a strategic priority for boosting the country's innovation capacity and competitiveness. These specialized spaces, which bring together government, academia, and industry, are seen as catalysts for fostering collaboration, knowledge sharing, and the commercialization of new technologies (Kusharsanto and Pradita, 2016). Third, the adoption and diffusion of information and communication technologies by Indonesian small and medium-sized enterprises have emerged as a critical driver of innovation and growth.

Indonesia SOEs are key players in the innovation ecosystem as well. State-owned enterprises in Indonesia have been playing a crucial role in shaping the country's innovation ecosystem. These SOEs, which are often dominant players in key economic sectors, have the potential to serve as anchors for innovation by providing access to capital, technical expertise, and market linkages. However, research suggests that the innovation performance of Indonesian SOEs has been mixed, with some enterprises demonstrating a high degree of innovative activity, while others lag behind.

One factor that may contribute to this disparity is the level of autonomy and flexibility granted to SOE managers in pursuing innovative initiatives. Studies have shown that SOEs with greater managerial autonomy and decision-making power tend to be more innovative, as they are better able to respond to emerging market opportunities and challenges. Additionally, the implementation of good corporate governance practices within Indonesian SOEs has been identified as a critical factor in driving innovation and enhancing company performance. Furthermore, SOEs and Small Medium Enterprises (SMEs) in Indonesia face significant barriers in accessing and utilizing digital technologies, including a lack of digital skills, limited access to financing, and weak supporting infrastructure. Addressing these barriers and strengthening the overall innovation ecosystem in Indonesia will be crucial for the country to realize its potential as a highly competitive and innovative global player (Harsanto et al., 2018; Kusharsanto and Pradita, 2016; Muljono et al., 2021; Setiawan, 2020).

This study explores the role of innovation ecosystem in the strategic entrepreneurship framework with an instrument of integrated innovation process in Indonesia SOEs as case study. Exploration and exploitation activities towards innovation opportunity need to be done in the framework of strategic entrepreneurship (Ireland et al., 2003) based on business innovation ecosystem approach (Adner, 2006; Yun and Liu, 2019). Entrepreneurship is a process centered around the concept of

recognizing, creating, seizing, and/or discovering opportunities (Schendel and Hitt, 2007). Innovation serves as a specific tool for entrepreneurs to achieve their goals (Drucker, 1985). Strategic entrepreneurship is the integration of entrepreneurship and strategic management. Entrepreneurship and strategic management are two different but complementary aspects in achieving company performance and wealth creation (Ketchen et al., 2007). There are very limited studies regarding open innovation, strategic entrepreneurship and impact of innovation ecosystem towards dynamic capability and business model innovation in the orchestration of integrated innovation process in SOEs. This study also argues that Indonesian SOEs' low competitiveness and innovation performance being influenced by the SOEs' innovation process which still tends to be closed internally or runs independently and has not been optimally orchestrated, as they are a risk-averse, bureaucratic, conservative, public organization and requires a systemic approach to manage the process (Pardyanto and Fontana, 2017).

2. Materials and methods

2.1. State-owned enterprises

State-Owned Enterprises (SOEs) are established to achieve various internal and external objectives, ranging from national security to social cohesion. Many researchers view SOEs as public enterprises due to their public mission. The active involvement of the government in the economy through SOEs is justified by three main reasons: market failures (traditional industrial policy argument), social objectives (social argument), and normative public welfare approaches (public value argument). Fundamentally, SOEs are economic entities similar to private enterprises, with the primary distinction being their majority state ownership (Orchad, 2016). An SOE is a company that is (wholly or partially) owned and controlled by the state (Peng et al., 2016) and is managed with principles of prudence and good corporate governance (Orchad, 2016).

However, existing studies suggest that state-owned enterprises and privately-owned enterprises exhibit distinct patterns and drivers of innovation due to their differing institutional logics, environmental pressures, and resource en dowments (Liu et al., 2020). One key distinction is that state-owned enterprises are often seen as potential drivers of innovation and innovative policies, given their capacity to pursue objectives beyond profit maximization, such as social welfare maximization. This is facilitated by their dominant market position and large customer base, which can provide the necessary scale and resources to engage in ambitious innovation efforts. In contrast, privately-owned enterprises may be more constrained in their innovation activities, as they are primarily focused on enhancing their competitive position and profitability. (Liu et al., 2020)

Moreover, the literature suggests that the type of innovation also differs between state-owned and privately-owned enterprises. Privately-owned firms may be more inclined towards product innovation, as they seek to differentiate their offerings and cater to evolving customer preferences (Liu et al., 2020). On the other hand, state-owned enterprises may be more oriented towards process innovation or business model, as they aim to improve operational efficiency and maximize social welfare

(Cobo et al., 2023; Liu et al., 2020). The literature also highlights that the relationship between ownership structure and innovation is not always straightforward. The degree of state ownership, the specific industry context, and the firm's resource and capability endowments can all influence the innovation dynamics within state-owned enterprises (Daneji et al., 2019; Liu et al., 2020; Perea, 2019). Overall, the existing research suggests that state-owned enterprises and privately-owned enterprises exhibit distinct patterns and drivers of innovation, reflecting their differing institutional logics, environmental pressures, and resource endowments (Cobo et al., 2023; Daneji et al., 2019; Liu et al., 2020).

2.2. Literature review

This research refers to the innovation & entrepreneurship disciplines (Rubenstein, 1994; Schumpeter, 1934), with the framework derived from resource-based theory (Barney, 1991) of strategic management disciplined. Key theories that will be utilized in the analysis of this research will be elaborated. These include dynamic capabilities, open innovation, innovation ecosystems and collaborative advantage, as well as strategic entrepreneurship process (Hitt et al., 2011; Ireland et al., 2003) as the proposed framework of integrated innovation process in the SOEs. Overall, the theories utilized are depicted under the theoretical framework outlined below in **Figure 1**.

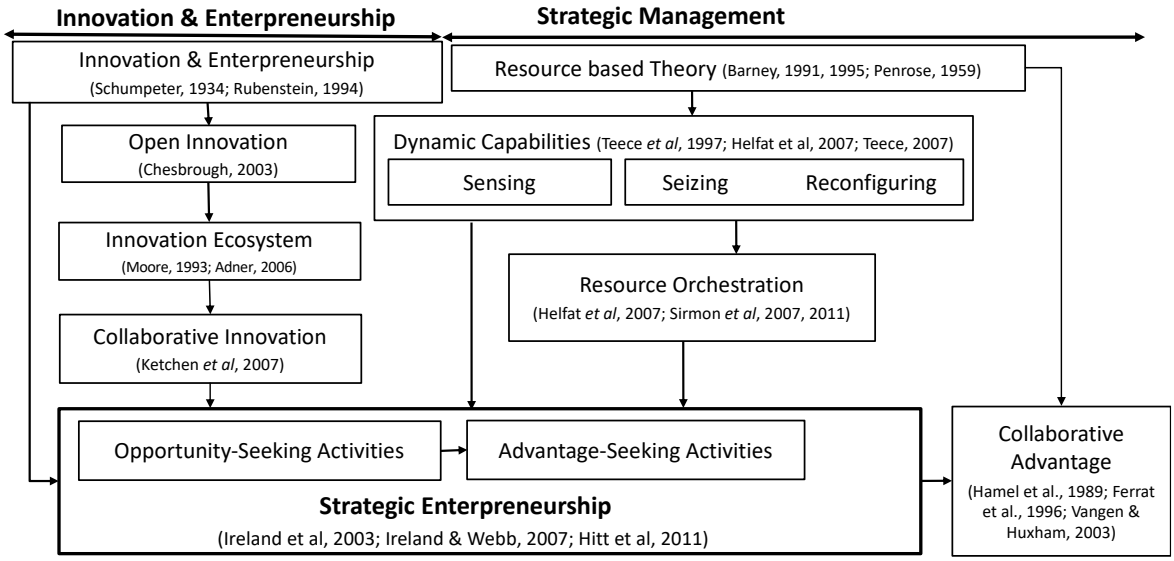

Figure 1. Umbrella theory.

2.2.1. Open innovation and quadruple helix

Henry Chesbrough (2003) describes open innovation as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively". This implies that open innovation is a symbiotic relationship form between the company and entities outside the company. An industry that conducts open innovation tends to improve internal efforts by aggressively seeking external insight in a variety of ways. Open innovation

orchestrates internal and external resources and capability to generate new technologies and identify new path to the market.

Open innovation can also be defined as the deliberate use of knowledge and information, both from outside and within, to accelerate innovation at the internal level and expand the market by using innovation from external parties (Wang et al., 2011). The open innovation paradigm has grown due to increasing skilled workers' mobility, venture capital growth, external ideas sourcing, and an increase in external suppliers' capability. These factors suggest knowledge is not proprietary to the company anymore and resulted in a new knowledge market. It may reside in competitors, customers, suppliers, employees and universities (Chesbrough, 2003).

Wikhamn and Wikhamn (2013) further argued that there are two perspectives of open innovation: (1) Firm perspective: it focuses on how individual companies engage in open innovation activities, such as collaborating with external partners, leveraging external knowledge and resources, and managing innovation processes internally while integrating external contributions. (2) Ecosystem perspective: This perspective considers open innovation within the broader context of innovation ecosystems, emphasizing the interconnectedness and collaboration among various actors, including companies, universities, research institutions, government agencies, and other stakeholders. It views innovation as a collective effort involving interactions and exchanges within the ecosystem rather than solely within individual firms.

Apart from open innovation, this study also uses the quadruple-helix theory which identifies connections or relationships between various stakeholders. Quadruple-helix is a series of interactions between government, industry and academia that encourage innovation and increase economic and social growth in an area by integrating the role of social communities (Carayannis and Campbell, 2009; Carayanis and Grigoroudis, 2016).

The Quadruple Helix theory emerged after Afonso et al. (2012) argued that the triple helix was not sufficient to support innovative growth in the long term and emphasized the importance of integrating public perspectives based on media and culture. Triple-helix describe a non-linear model of innovation process through interaction of industry, government, and university. Each helix not only develop by themselves, but also exchange products, services, and knowledge.

Therefore, the quadruple helix adds a fourth helix to the innovation system, namely civil society (Khan and Al-Ansari, 2005; Lijemark, 2004). Eriksson et al. (2006) also argued that in user-oriented innovation, civil society (users) are co-producers of the innovation. Society plays a role that is as important as that of government support organizations, research institutions, governments, and companies. It facilitates interaction of top-down policies and initiatives from bottom-up, promotes co-creating knowledge and value, that applicable to both developed and developing economies.

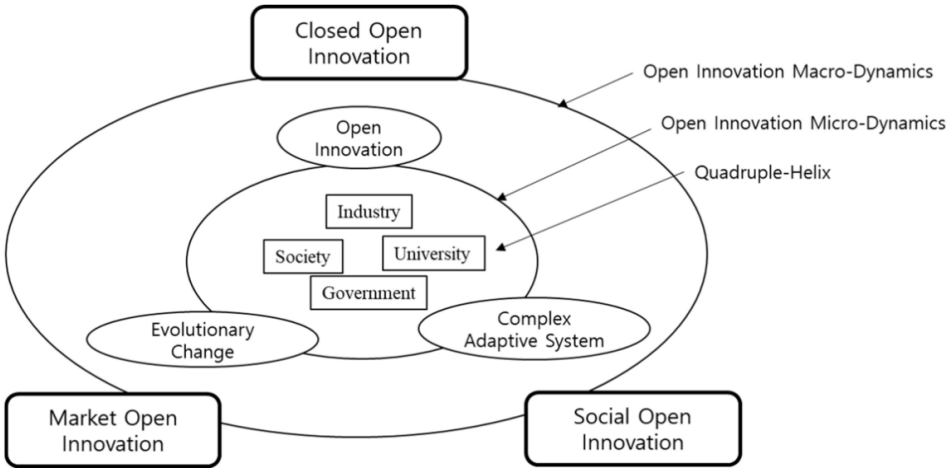

Figure 2. Micro- and macro-dynamics of open innovation with a quadruple-helix model.

Source: Yun and Liu (2019).

As shown in **Figure 2** above, Yun and Liu (2019) propose conceptual framework to understand open innovation in macro and micro level with addition to the dynamic roles of quadruple-helix actors. From micro dynamics perspective, open innovation can be described as cyclical dynamic of open innovation, complex adaptive systems, and evolutionary change. Open innovation increases the complexity of firm, sectoral, regional, or national innovation systems. It will require a complex adaptive system to control the complexity which will be achieved with creative development at the evolutionary change level. A focal firm can gain new opportunity through evolutionary changes as long as complexity of open innovation can be well controlled (Yun et al., 2016).

From macro-dynamic perspective, open innovation can also be described as cyclical dynamics among market open innovation, closed open innovation, and social open innovation. Social entrepreneurs initiate social open innovation by creating new combination and connection of technology and society. It is becoming the source of market open innovation, promoting new entrepreneurs and start-ups to create new combinations and connections between technology and market. Market open innovation then motivates closed open innovation initiatives through merger and acquisition, partnership, and various open innovation collaboration. Dynamic cyclical balance of these three kinds of open innovations promotes the economy growth of a country quantitatively and qualitatively (Yun et al., 2018).

In the quadruple-helix model there are four dynamic roles and conditions that strengthen relationships and support open innovation theory (Yun and Liu, 2019):

1) Industries continuously adopting open innovation practices and platforms,
2) Role of governments in moving toward permission-less open innovation, shifting from regulation control toward facilitation.
3) New role of universities as proactive collaboration agencies, from technology transfer to knowledge co-creation.
4) Societal engagement of society and customers with the shared economy.

Yun and Liu (2019) also argue that open innovation provides alternatives for products, services, and business model innovation from the traditional closed

innovation, either at the firm or supply-chain level. At the organizational level, closed innovation occurs with internal Research and Development (R&D) resources. Industries, universities, governments, and societies are static and separated by limited interaction. At the supply-chain level, both formal closed innovations based on partnerships and informal open innovation are observed from both industry and government perspectives. The business ecosystem expanded innovation activities from formal supply-chain partners to indirect collaboration in various forms. Apart from industry initiation, universities, governments, and societies are actively contributing to value co-creation which showed in **Table 1**. Thus, sustainability can be achieved through the joint effort of resource and knowledge sharing, aiming for a long-term impact on the economy, the environment, and society.

Table 1. Features of closed and open innovation at different levels.

Role	Organization	Supply Chain	Business Ecosystem
Industry	Closed innovation: In-house R&D in large firms	Closed innovation: Joint R&D activities between supply chain partners, lean/agile supply chain Open innovation: Open platform for crowdsourcing, IP in-licensing, joint venture activities	Open innovation: Strategic alliance of large firms and SMEs informal network, various knowledge sharing, and collaboration
University	Closed innovation: Education and S&T research	Closed innovation: Technology transfer from university of industry based on specific projects	Open innovation: Active simultaneous co-creation with industry
Government	Closed innovation: Policy making	Closed innovation: Standardization, collaboration on specific projects Open innovation: Open platform to obtain ideas and solutions	Open innovation: Facilitating by infrastructure, framework and indirect support, broad collaboration, initiating responsible innovation
Society	Closed innovation: Passive users	Closed innovation: Customer need and relationship management	Open innovation: Customer engagement, resource and demand sharing, co-creation of product and service

Source: Yun and Liu (2019).

2.2.2. Innovation ecosystem

Innovation ecosystem is a form of an open innovation process that includes research and development functions and various elements outside the organization. It consists of a focal firm (in this research is a SOEs), its network of suppliers, customers and complementors (Adner and Kapoor, 2010). Feng et al. (2021) also attempted to classify the types or forms of innovation ecosystems. According to differences in scope, innovation ecosystems can be divided into National Innovation Ecosystems (NIEs) and Regional Innovation Ecosystems (RIEs). Meanwhile, based on differences and similarities in attributes, innovation ecosystems can be divided into Industrial Innovation Ecosystems and Enterprise Innovation Ecosystems (Jiang et al., 2019). The type of innovation ecosystem that will be adopted in this research is Enterprise Innovation Ecosystems (EIE), specifically describing the application of open innovation ecosystems in Indonesia SOEs. The perspective used is an ecosystem where SOEs is the focal firm and interacts with other actors in the ecosystem which being showed in **Table 2** below.

Table 2. Innovation ecosystem types.

System	NIEs	RIEs	IIEs	EIEs
Classification standard	Spatial geography	Spatial geography	Attribute similarity	Attribute similarity
Level	Meso	Medium	Medium	Micro
Perspective	Country	Region	Industry	Enterprise
Aim	Serve national goals	Develop regional economy	Development area	Develop technology and obtain resource
Innovation focus	National economy	Regional economy	Industrial development	Business growth

Source: Feng et al. (2021).

Jacobides et al. (2018) also argue that scale of business currently ranges from individual firms to supply chains, evolve from hierarchical management to ecosystems that feature collective investments and interactive management. Scaringella and Radziwon (2017) identifies three streams of presence in ecosystems literature. The first one is business ecosystems, explaining an ecosystem as communities of organizations, individual and institutions, beyond the boundary of a single company or industry (Moore, 1993). The second is innovation ecosystem, which focuses on knowledge activities through collaboration between diverse actors. The last stream is the exploration of open platform to facilitate value creation and knowledge sharing between organizations or government.

Firms need the capability to sensing the opportunity and partners, building coalition, collaboration and working towards the same goal in an ecosystem (MacCormack et al., 2007). SOEs as a firms should not only play its own parts, but also to bring all part of ecosystem on the table. SOEs must try to develop a friendlier and easier environment for innovation. Innovation ecosystem is a complex network of actors, resources, and connection, which consist of stakeholders and rules. Innovation ecosystem that promotes research, develop innovative capability through collaboration between organization and integration of supply chain, could help firms in emerging countries to develop its own competitive advantages (Xie and Wang, 2020). Furthermore, the dynamics of the open innovation ecosystem are characterized as interactions between four quadruple-helix actors. Therefore, the SOEs open innovation ecosystem can be considered as an interaction and collaboration between SOEs and academics, government, industry and society. This paper uses the quadruple helix model to classify and further understand the actors involved in the SOEs' innovation ecosystem, as follows:

Government support

The open innovation ecosystem in Indonesian state-owned enterprises has its uniqueness in the complexity of relationships with stakeholders, especially SOEs that have strategic missions or social orientations and undertake national-scale assignment projects from the Government. The Government plays a role in initiating open innovation through the effective implementation of public projects and facilitating an innovative atmosphere through national policies (Liu et al., 2021; Yun and Liu, 2019). SOEs can gain resource advantages and strategic roles due to their assignments, thus exerting significant influence in their ecosystems. However, strong government and legislative interventions color management decisions in utilizing their innovation ecosystems, especially considering the Government's ownership of SOEs' shares. On

the other hand, the Government also conducts nurturing and restructuring efforts to positively influence the development of innovation ecosystems to enhance the value proposition of SOEs.

Industry and SOEs

Zhang et al. (2011) in a case study of industries in the UK, outlined that interaction activities among stakeholders or industry partners in the process of project development and implementation can lead to the creation of effective and efficient ideas and process development. This finding is consistent with the case study by Holmes and Smart (2009) on dyadic engagement activities from inter-organizational or inter-company collaborations, which can provide innovation opportunities facilitated by the exploration and exchange of ideas. Lager (2016) further reinforces that industries also play a role in the product innovation process at every stage (fuzzy front end; product development; manufacturing; purchasing; start-up; production). The interaction of companies with other companies and also with intermediary firms has been shown to strengthen their innovation ecosystems and contribute to the increase in product and service innovation of those companies (Xie and Wang, 2020).

University

Hasche et al. (2019) argues that the involvement of academics in quadruple-helix collaborations has been seen as a complex task, where academics have long valued publications and research grants more than collaborating with quadruple-helix stakeholders (McAdam et al., 2018). Meanwhile, in the case of developing countries, the involvement of academics and universities has a positive impact on firm innovation performance (Crespi and Zúñiga, 2012). A company is more likely to choose university partners because they are important sources of new technological knowledge for the innovation process (Audretsch, 2014). In the context of developing countries, empirical studies have demonstrated the positive benefits of knowledge transfer between universities/research centers and companies, especially when it is related to long-term benefits (De Fuentes and Dutrenit, 2012).

Society

Carayannis and Grigoroudis (2016) further develop quadruple helix concept by adding society/user's network. Collaboration with users or the community combines top-down policies and bottom-up grassroots initiatives, creating shared knowledge and value, which can be applied to both advanced and developing countries (Khan and Park, 2012; Park, 2014). As also stated by Barroso (2010), economic growth in the modern era requires cooperation among all economic actors, including social partners and civil society. Eriksson et al. (2006) also argue that in user-oriented innovation, civil society (users) are co-producers in innovation.

2.2.3. Dynamic capability

The dynamic capability perspective is rooted in the resource-based view (Barney, 1991). The resource-based view sees that a company's competitive advantage can be achieved through its resources and capabilities of the company. Therefore, the competitive advantage will be obtained if the resources owned are VRIO (valuable, rare, inimitable, and well organized). Resources consist of assets and capabilities. Asset resources can be defined as assets owned by a firm semi-permanently, whether

tangible or intangible (Winter, 2003). Capabilities are business processes that reflect the knowledge an organization possesses to leverage, combine, and coordinate various resources to perform specific tasks (Prahalad and Hamel, 1990). Makadok (2001) outlines that the difference between resource and capability is that capability is specific and inherent to the organization or company, whereas resources are not specific and inherent. Meanwhile, strategic assets are a form of resource that is non-tradable and can form and generate sustainable comparative advantages (Dierickx and Cool, 1989).

The dynamics and changes that continuously occur in the business environment require companies to adapt. Thus, dynamic capabilities (DC) as the ability to continuously create, expand, improve, protect and maintain configuration relevance of the company's unique and strategic assets are capabilities that determine the company's adaptation efforts to disruptions or changes in its business environment or in its business ecosystem, especially during times of rapid technological development (Birkinshaw et al., 2016). Eisenhardt and Martin (2000) define dynamic capabilities referring to prior publications by Teece et al. (1997) and Kogut and Zander (1992), which is the process by which a company integrates, reconfigures, acquires, and releases resources that ultimately fit and even create market changes. This is consistent with Helfat et al. (2007), who define DC as the organization's capacity to create, extend, or modify their resource base. A firm's position can improve if its resources can be developed to meet the VRIO criteria (Teece, 2014). DC can become a company's strategic routines to achieve new resource configurations as markets change. Therefore, it can be understood that dynamic capabilities are the firm's ability to manage the resources it possesses beyond the business or activities they conduct on a day-to-day basis, consisting of Sensing, Seizing, and Reconfiguration capabilities (Teece, 2007).

2.2.4. Resource orchestration

Further advancement in understanding of dynamic systemic behaviour in the innovation process emphasizes the urgency of orchestrating external and internal resource capabilities because a company's internal resources are limited. Schumpeter conveyed in the Theory of Economic Development (1934) that innovation is achieved by entrepreneurs who develop new combinations of existing resources (Swedberg, 1991). In its development, producers or companies nowadays no longer create innovation solely using their own organizational resources (Chae et al., 2014; Santhanam and Hartono, 2003). Resource orchestration for innovation is the process of arranging all company resources and external resources to generate combinative capabilities and problem-solving. The theory of resource orchestration argues that each resource has its own characteristics, and the correlation of resources can result in potential advantages in orchestration style. This emphasizes the characteristics of resource impression and complementarity (Taher, 2012).

Resource orchestration is the operationalization of dynamic capabilities to gain competitive advantage, since the value of competitive advantage lies in the resource configuration formed by the resource orchestration process. Sirmon et al. (2011) integrates the resource management framework and asset orchestration theory to

produce a new resource orchestration framework and focuses on how management allocates resources to achieve competitive advantage.

Resource orchestration is the process of structuring, bundling, and leveraging company resources to increase competitive advantage (Sirmon et al., 2011). Based on the various theories mentioned above, it can also be interpreted that resource orchestration is the capability to deliberately build and manage inter-company resource networks to innovate. Open innovation model adoption intended to address the resource orchestration challenges related to the lack of resources, knowledge, and expertise within the company.

2.2.5. Strategic entrepreneurship process

A strategic entrepreneurial process framework is needed for companies to adapt to the dynamic changes in the business environment since companies need to make a series of decisions in an effort to create new innovations (Ireland and Webb, 2007). Innovation itself is instrument for entrepreneurship (Drucker, 1985). Therefore, innovation performance can be seen as a mechanism for measuring the performance of strategic entrepreneurship in a systematic way that represents innovation input, process, output and outcome innovation system (Aryanto et al., 2015; Fontana and Musa, 2017).

Strategic entrepreneurship (SE) is always concerned with opportunity-seeking and advantage-seeking behaviours resulting in value for individuals, organizations, and/or society (Hitt et al., 2011) through the development of consistent innovation stream. Opportunity-seeking (i.e., entrepreneurship) and advantage-seeking (i.e., strategic management) behaviours are necessary for wealth creation, yet neither alone is sufficient (Amit and Zott, 2001; Hitt and Ireland, 2000; McGrath and MacMillan, 2000). Thus, this framework is used in this research to depicts integrated innovation process in SOEs and how it interacts with their ecosystem.

Ireland et al. (2003) defined strategic management and entrepreneurship as relating to the development and creation of corporate wealth through the synergy of strategic and entrepreneurial activities (opportunity seeking activities and advantage seeking activities). Ireland et al. (2003) also developed a strategic entrepreneurship model where an entrepreneurial mindset, culture and leadership are needed by companies to manage resources through strategic actions and entrepreneurial actions to develop innovation. A further model of strategic entrepreneurship is the input-process-output model proposed by Hitt et al. (2011), which integrates environmental influences in the strategic entrepreneurship process to explain the resources managed in competing with competitors. Resource orchestration itself is also considered the heart of the process in the strategic entrepreneurship model, which showed below in **Figure 3**. It also emphasizes environmental factors as one of the inputs of SE processes, among other organizational and individual resources.

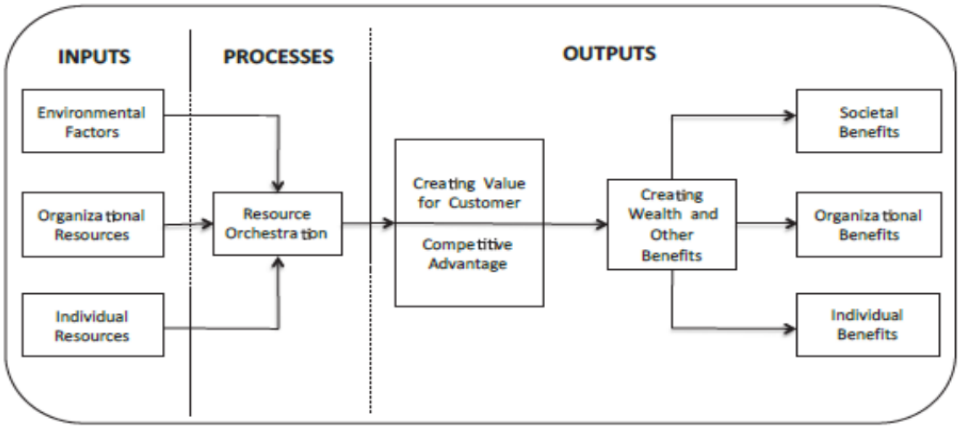

Figure 3. Input-process-output model of strategic entrepreneurship.
Source: Hitt et al. (2011).

2.2.6. Sensing capabilities

Tseng and Lee (2014) argue that dynamic capability will enhance performance and provide competitive advantage of an organization. Resources need to be developed into dynamic capability (sensing capability as one of dynamic capabilities) to achieve sustainable competitive advantage and promote collaborative actions. The sensing capabilities variable relates to input factors that represent an organization's ability or capability to read the environment, identify opportunities and identify potential partners in its ecosystem. This variable represents the dynamic capabilities (sensing, seizing, and reconfiguring) and development of the Strategic Entrepreneurship model (Ireland et al., 2003), which shows that there are individuals and organizational resources and capabilities as input for a strategic entrepreneurial framework that has been influenced by environmental (ecosystem) factors.

Sensing also constitutes gathering relevant market information (Teece, 2011). This capability is important for SOEs to be able to analyse its surrounding environment, understand customers, and consolidate internal ideas. Management of SOEs should have knowledge, expertise, and experience to recognize opportunities and initiate proper action in response. Sensing capability has positive influence on the product and services innovation (Kodama, 2018).

This sensing capability variable will become a link between the condition of the innovation ecosystem in the company and the innovation strategy that will be formulated and implemented by the company. Good sensing capabilities are needed to explore innovation opportunities according to the strategic entrepreneurship framework.

2.2.7. Innovation strategy

Innovation strategy is an organizational decision that determines the extent and manners in which innovation is developed to carry out its business strategy with an effort to achieve a certain level of performance (Aydinoglu, 2007). Innovation can fail if a mature company such as large SOEs use the same processes as start-up to manage main products and innovation processes (Viki et al., 2017). Innovation strategy will enable company to direct its decision and policy to manage technology and resources to accomplish company objectives to innovate and thus creating value and developing

competitive advantage (Dodgson et al., 2008). Strategy formulation, especially corporate and business strategy, is an obligation for SOEs management and is the basis for various strategic initiatives, including innovation initiatives, which are carried out within a certain period. Due to its characteristics as a risk-averse organization, SOEs need to formulate and formalized its strategy before taking initiatives.

Ecosystem-oriented innovation strategy will direct SOES to pro-actively and effectively collaborate through sharing of ideas, knowledge, skill and opportunity, to build its strategic positioning in the ecosystem and aligning its internal and external initiatives, with the actors in the innovation ecosystems (Visscher et al., 2020). Based on various literature related to the innovation strategies, we adopted the dimensions from Dodgson et al. (2008) to classify a company's innovation strategy, namely as follows: 1) complexity and complicatedness of the innovation process required; 2) range and depth of resources required; 3) innovative capabilities required, which can be measured and classified into four levels of innovation strategy, i.e., passive, reactive, active, and proactive.

2.2.8. Business model innovation

The business model is one of the concepts in strategic management (Demil et al., 2018). Chesbrough and Rosenbloom (2002) define a business model as a construction that links the characteristics and potential of technology as an input process to economic output through customers and markets. Jang et al. (2019) also explained that a business model can be defined as a value-centered system designed by the focal firm and operated by them and their partners to meet market needs.

Business model innovation (BMI) is a company's response to changes in the sources of value creation (Schneider and Spieth, 2013). Meanwhile, Amit and Zott (2020) explain that BMI is "the introduction of a new business model (in its content criteria and/or structure and/or governance and/or value logic) into the product-market space where the company competes". BMI is related to corporate strategic entrepreneurship, namely that companies can consider uncertainty in the environment as a potential source of opportunities that can be explored and exploited (Hitt et al., 2001). Academics agree that BMI can be a "new source" for the competitive advantage (Zott and Amit, 2007). Clauss (2016) proposed the scope of business model innovation through its value creation, value proposition/delivery, and value capture innovation.

2.2.9. Collaborative advantage

Competitive advantage teaches how to mobilize a company's resources to create better offerings for consumers compared to competitors. However, with increasing levels of uncertainty, interdependence, and complexity threatening competitive strategies, managers need to explore new ways to compete through collaborative efforts. Collaborative advantage can help companies achieve better performance with fewer internal resources by mobilizing employees, customers, partners, and stakeholders to support the company in reaching common goals. This collaboration can foster innovation, access broader consumer and market bases, build stronger loyalty, generate higher revenues, and develop more strategic partnerships.

Porter's Five Forces on Teece (2009) provide the essence of strategy formulation to address competition, while the essence of dynamic capabilities strategy relates to selecting and developing technologies and business models that build competitive

advantage through assembling and orchestrating hard-to-imitate assets, which in turn shape the competition itself. This underpins the importance of developing collaborative advantage, given that the ecosystem serves as a dynamic capabilities paradigm for companies to assess their environment, where sustainability and evolution are influenced by interaction and collaboration initiatives among its actors.

Ferratt et al. (1996) defined the collaborative advantage as the advantage gained by a group of companies because of their collaboration compared to their competition. Collaborative advantage can also be defined as a strategic advantage derived from relational benefits, i.e., benefits obtained from collaborative partners through the combination, exchange, and joint development of unique resources through partnership or collaboration (Vangen and Huxham, 2013). Collaborative advantage also related with synergy result obtained from the company from its collaborative actions of which cannot be achieved solely by itself. Sustainability and evolution of the business ecosystems as dynamic capabilities paradigm depend on interaction and collaborative initiatives that can be represented by its collaborative advantage. Collaborative advantage articulates the way to do business of which can be more beneficial to the customer, communities, and ecosystem. It will enable the company to win competition, securing its position as market leader, and improve market performance, together with their innovation partners (Eng and Okten, 2011).

State-owned enterprises face unique challenges in fostering innovation and competitive advantages, as they operate within a complex web of external stakeholders and constraints. However, their large scale and market dominance can also position them as potential hubs of technological advancement, provided they can effectively leverage their resources and adapt to changing industry dynamics. The establishment of collaborative advantages in state-owned enterprises is influenced by the external innovation ecosystem in several key ways. Firstly, the ability to establish unique internal management institutions and decision-making systems that enable agility and responsiveness to market trends is crucial (Lengnick-Hall, 1992). These internal structures must be designed to facilitate open innovation practices, such as active collaboration with external partners and strategic outsourcing to specialists. (Henttonen and Lehtimäki, 2017) As the study on collaborative innovation in SOEs suggests, a blend of internal strengths and external partnerships (ie., start-ups) can help state-owned enterprises compensate for weaknesses and gain competitive edge, especially pursuing disruptive innovations (Utoyo, 2020).

Furthermore, the business model and industry positioning of state-owned enterprises play a significant role in their capacity to leverage the external innovation ecosystem. Moreover, the industry context and the business model of the state-owned enterprise play a significant role in determining the types of collaborative advantages that can be cultivated. In industries dominated by SOEs, the sheer scale and resources available can provide a foundation for driving technological innovation, provided the management is able to effectively coordinate and leverage these assets. As the research on external linkages in SMEs indicates, the strategic management of collaborations, particularly with larger firms, can help state-owned enterprises access complementary resources and know-how that they may lack internally (Dodgson and Rothwell, 1991). However, the tendency towards bureaucracy and risk-averse decision-making in many state-owned enterprises can hinder their ability to adapt to rapidly evolving industry

requirements (Pardyanto and Fontana, 2017). The diverging understandings of innovation across stakeholders, as well as the internal organizational constraints of state-owned enterprises, can pose significant challenges. SOEs must be able to optimize their internal structures and management practices to foster agility, while simultaneously leveraging their scale and resources to engage in open innovation activities with external partners.

In this study, the collaborative advantage is operationalized with five dimensions based on research by Cao and Zhang (2011). The first is process efficiency, which is the degree of the company's collaborative process with partners which results in more competitive costs than the main competitors (Bagchi and Skjoett-Larsen, 2005). The second is offering flexibility, the level of flexibility in inter-company relations that can support changes in products (goods and services offerings). Third, there is business synergy with collaboration partners. Fourth, quality is the ability of companies and partners to offer quality products and create added value for customers (Li et al., 2006). The fifth is co-innovation, which is working with companies and partners to introduce new processes, products and services (Hanafiah, 2018; Kessler and Chakrabarti, 1996).

2.3. Research methods

The method used for this research is a mixed qualitative and quantitative methodology. This research began with initial exploratory semi-structured interviews with senior management involved in innovation at 4 state-owned companies in Indonesia with different size and industry (banking, tourism, aviation, and pharmacy) in September–December 2022. The objectives were to explore innovation process in the typical SOEs and role of other actors outside the firm towards the innovation processes. The result is consistent with the integration of conceptual model and proposed preliminary research model and measurement variables.

Quantitative method was used with an explanatory approach, namely research that will explain the relationship between variables that influence the researcher's hypothesis. In addition, the explanatory method is used which aims to explain the position of the variables being studied and the relationship between one variable and another to obtain the meaning and implications of the problem to be solved systematically, actually and accurately. The unit analysis was the SOEs, and the respondent was senior management level involved in innovation process or policy.

The trial questionnaires were filled out as part of the pre-test process with the aim of ensuring the respondent's understanding of the statements in the questionnaire. An initial test of the draft questionnaire containing 119 statements have been conducted on 30 respondents represent each SOE. The pre-test data from 30 companies were then processed using statistical software suites (SPSS) by conducting factor analysis on each latent variable with its indicators. The final survey was then distributed to 261 state-owned enterprises (SOEs) on May–September 2023, and 160 valid respondents were collected to represent each SOE. Formal letter from ministry of SOEs office and researcher contain instruction and explanation of the survey were distributed to all 261 SOEs and its subsidiaries. After removing incomplete responses, the respondents represented SOEs from various sectors including financial (18%), property (16%), transportation (13%), IT & Services (9%), energy (7%), mining (6%), agroindustry

(6%), chemical (6%), manufacturing (5%), tourism (5%), trading (4%), and pharmacy (2%). The education background is at least bachelor degree (51.3%) and master degree (43%). The majority of respondents (71.9%) were at a level of 2 or 1 level below the Board of Directors.

This research utilizes the structural equation model – partial least square (SEM-PLS) method (using SmartPLS 4.0) to explore the relationships between constructs in the proposed research model considering the exploratory nature of the research, the limited number of observed data/companies, and the flexibility of SEM-PLS in handling different indicators, both in formative and reflective forms, as found in the research model.

2.4. Research model and hypotheses development

To summarize our analysis from literature and industry review, we propose the integration of the open innovation ecosystem conceptual model as illustrated below in **Figure 4**, which addresses interactive roles of industry, government, university, and society as part of an innovation ecosystem that will influence resource orchestration and innovation process in state-owned enterprises, and also being affected by micro- and macro systems. Innovation ecosystem in micro-level consists of interaction between state-owned enterprises and knowledge infrastructures that will grow and interacts with other systems (education, finance, labour, intellectual property, policy, and welfare), to form macro-system, and vice-versa (Fontana, 2011; Lundvall, 2007).

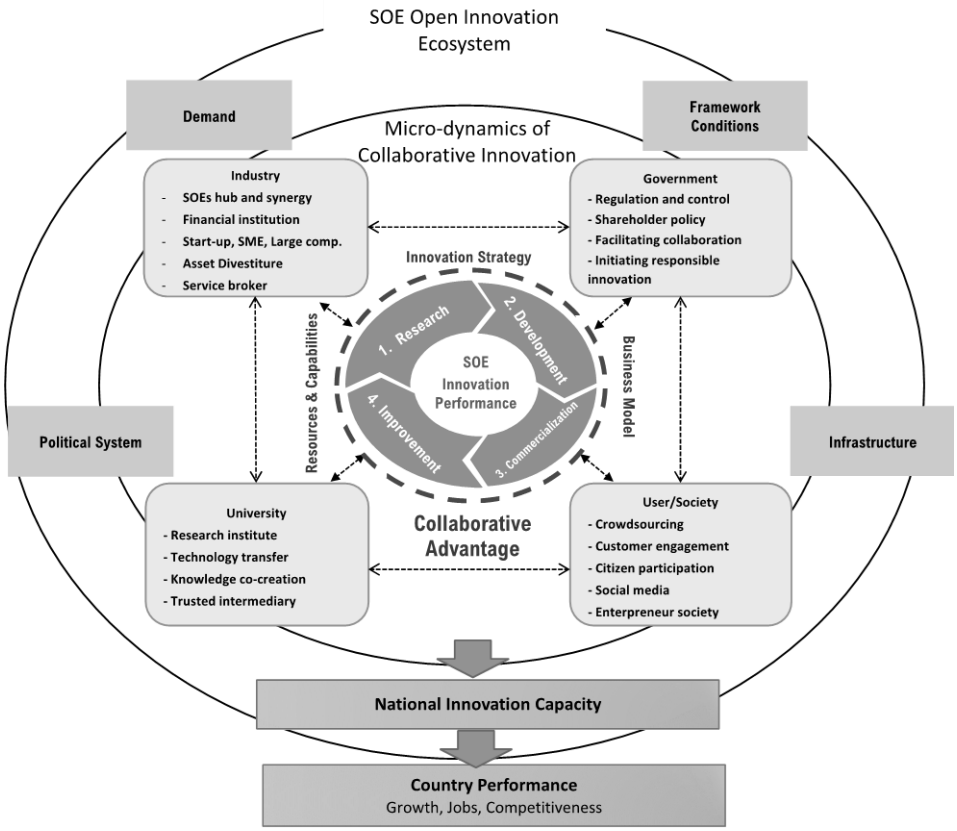

Figure 4. Integration of research conceptual models.

The perspective of this research is state-owned enterprises as the central agent or focal firm of open innovation actors in the innovation ecosystem. We study the roles and relationships between actors as part of an open innovation system using the reference quadruple-helix model that determines the government, university, industry (including SOEs) and society as key actors in the innovation ecosystem. The proposed conceptual model describes the integration between the quadruple-helix, open innovation process, collaborative innovation, innovation ecosystem, and other factors in the ecosystem environment that influence the implementation of open innovation to achieve sustainable innovation performance. Open innovation involves various actors co-creating knowledge together across different levels. According to Yun and Liu (2019), this phenomenon should be described as dynamic process rather than static characteristics. The relationship between its actors demonstrates interaction and co-evolution on the macro-dynamic level.

Continuous open innovation process in state-owned enterprises is directed by innovation strategy and business model as part of resource orchestration that involve outside resources to be used internally or coupled as part of collaborative innovation. As an extension of the government's hands in the business sector, a state-owned enterprise has an orientation toward the role of creating economic and social/public values, as well as execution of government mandate. State-owned enterprises are directed to balance economic performance and public service aspects. Therefore, we are also taking into account the national innovation system that affecting the innovation process and aim to increase country performance by enhancing national innovation capacity.

Through the initial integration of the research conceptual model above, we proposed following research model to explain the role of the business innovation ecosystem in the input-process-output model of strategic entrepreneurship framework (Hitt et al., 2011), with an integrated innovation process instrument that is operationalized by the innovation strategy and strengthened by business model innovation which in turn will have an impact on the competitiveness and performance of state-owned enterprises.

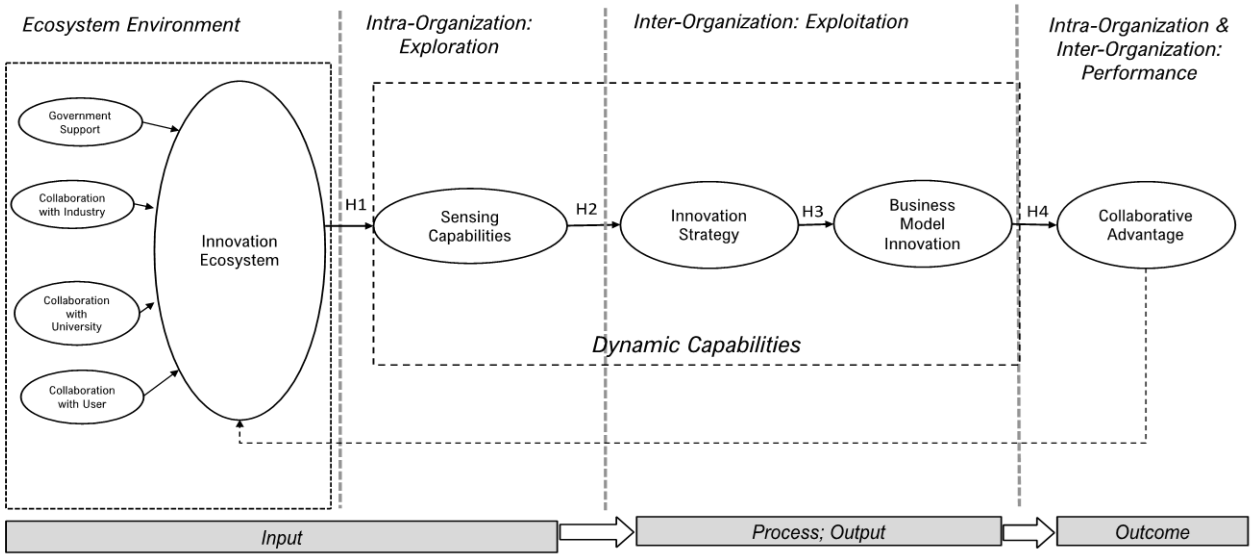

Figure 5. Research model.

This research model outlines the role of the business innovation ecosystem in the strategic entrepreneurship process using an integrated innovation process instrument. State-Owned Enterprises can undertake various business innovation initiatives, including products, services, and business models. The key type of innovation to focus on is business model innovation, which provides a strong foundation for various products (innovative goods or services) and, in turn, impacts the competitiveness and performance of SOEs as illustrated below in **Figure 5**.

The business innovation ecosystem (with a quadruple helix model) is considered a contextual variable, without which the strategic entrepreneurship process in SOEs and their innovation processes might be challenging to orchestrate. A strong and open innovation ecosystem can be assessed through several dimensions: 1) Government Support; 2) Collaboration with Industry; 3) Collaboration with Universities; 4) Collaboration with Users. This innovation ecosystem plays a role from the early stage, starting with strengthening the SOE's sensing capabilities to read and identify innovation opportunities available in the ecosystem, which will continue to affect subsequent stages of the innovation process.

In the first stage, exploration: A strong (conducive) business innovation ecosystem can facilitate (accelerate) the process of exploring innovation opportunities. The strength and conduciveness of the innovation ecosystem are determined by the intensity of interactions, support, and active collaboration of SOEs with the Government, Industry, universities, and society. A conducive and open innovation ecosystem will enhance the SOE's sensing capabilities. The exploration of innovation opportunities in SOEs is influenced by the SOE's sensing capability, which involves reading the environment, identifying opportunities, and recognizing potential partners in the ecosystem.

The second stage is exploitation: Exploration of innovation opportunities supported by a conducive innovation ecosystem and strong sensing capabilities will serve as input in the orchestration of resources to realize the identified/created innovation opportunities from the exploration stage within the framework of strategic entrepreneurship in SOEs, represented by innovation strategy and business models. Innovation Strategy is a company's plan that determines the extent and manner in which innovation is used to execute its business strategy, aiming to achieve certain performance levels. An innovation strategy coherently orchestrates initiatives/activities in its innovation process with the goal of creating innovation and value propositions. Formulating and implementing an innovation strategy is an iterative and dynamic process, influenced by the external environment (innovation ecosystem) and the company's sensing capabilities, which affect the assessment of innovation opportunities during the exploration process. SOEs can formulate their innovation strategy at various levels: passive, reactive, active, and proactive. A proactive innovation strategy will enhance the innovation and openness of the SOE's business model to its ecosystem, represented by business model innovation (BMI). A business model is a mechanism in orchestrating the innovation process, complementing the company's strategy through an interdependent system of business activities designed by the SOE as a focal firm and carried out with its partners in the ecosystem to create value, innovate, and meet consumer needs.

The third stage is performance. An innovative, open, and ecosystem-oriented business model can facilitate the social and economic dissemination of the benefits generated by the company. Innovative strategies and business models coordinate resources and activities of actors in the innovation ecosystem for the development and implementation of innovation ideas, enhancing collaborative advantage as a proxy for the competitive advantage of SOEs. Collaborative advantage is a strategic and synergistic benefit derived from relational advantages, i.e., benefits gained from collaborative partners through the combination, exchange, and joint development of unique resources through partnerships or collaborations, which cannot be achieved individually.

Hypothesis development

The business innovation ecosystem (with the quadruple helix model) will be seen as a contextual variable, without which the strategic entrepreneurship process in state-owned enterprises and its innovation process will allegedly be difficult to orchestrate. In the exploration phase, a conducive innovation ecosystem will accelerate innovation exploration process. A strong and conducive open innovation ecosystem, which can be seen from several dimensions, namely: 1) government support; 2) collaboration with industry; 3) collaboration with universities; 4) collaboration with users, will improve sensing capability of state-owned enterprises. Their exploration process of innovation opportunity is affected by their capability to sense the environment, identify opportunity, and recognize potential partners in the ecosystem.

H1: Innovation ecosystem (IE) influences positively state-owned enterprises' sensing capabilities (SC).

The more conducive (intensive) the interaction between SOEs and their ecosystem (Government, Industry, Universities, Society interactions), the stronger their ability to identify innovation opportunities from their environment.

Exploration of innovation opportunity that is supported by conducive innovation ecosystem and strong sensing capability will become input for resource orchestration process to be manifested in the strategic entrepreneurship framework. Resource orchestration in SOEs will be represented by innovation strategy and business model innovation. Innovation strategy will be coherently orchestrated the initiatives/actions in the innovation process with the aim to create innovation and value proposition. Proactive innovation strategy will improve innovation and the openness of SOEs business models towards their ecosystem. Business model is a mechanism in innovation process orchestration of which complement company strategy in the form of interdependent business activity system that is designed by SOEs as focal firms and executed together with their partners in the ecosystem to create value through innovation to meet or solve customer demands. Business model innovation is the articulation of business innovation strategy that involves internal and external resources in the innovation ecosystem.

H2: Sensing capabilities (SC) influence the decision of innovation strategy (IS) types.

The higher the SOE's abilities to identify innovation opportunities, the more proactive the type of innovation strategy chosen by the SOEs.

H3: Innovation strategy (IS) formulation influences the business model innovation (BMI) types.

The more proactive the type of SOEs innovation strategy, the more innovative the business model run by the SOEs itself.

Furthermore, an open, innovative, and ecosystem-oriented business model will ease the distribution/dissemination of social and economic benefit/value produced by state-owned enterprises. Innovative strategy and business model will orchestrate resources and activities of the innovation ecosystems actors to the development and implementation of innovation ideas that will increase collaborative advantage as a proxy of competitive advantage. Improvement of business model performance of the actors in the ecosystem will affect each of the actors to gain benefit and value from collaboration.

H4: Business model innovation (BMI) influences positively the collaborative advantage (CA).

The more innovative the state-owned enterprises' business models, the higher the level of state-owned enterprises' collaborative advantage with/between/among their ecosystem actors.

3. Results and discussion

3.1. Initial exploration of the SOE's innovation process

Initial exploratory semi-structured interviews with senior management involved in innovation of four state-owned companies has been done to capture a snapshot of the innovation process and problem formulation. The following as illustrated below in **Table 3** are highlights of their profiles for consideration of various size, industry, and strategic value. The interview process for SOE's management was carried out in December 2021 with a time period for each interview between 1.5 hours and 2 hours. Interviews consist of questions regarding innovation process in the company; innovation governance availability and application; relationship, involvement or collaboration with external parties in the innovation process (universities, industry, government and society).

Table 3. Profile and innovation process in each state-owned enterprise.

Variable	SOE A	SOE B	SOE C	SOE D
Industry	Banking and financial services (Highly regulated)	Airport transportation (Highly regulated)	Tourism	Pharmacy and life sciences (highly regulated)
Established	Since 1895	Since 1984	Since 1980	Since 1890 (since 2020 become holding pharmacy industry)
Structure	Operational Holding – seven subsidiaries	SOE—five subsidiaries (under holding Aviation)	SOE—1 subsidiary	Holding company—2 holding member
Strategic value	The largest bank in Indonesia based on the size of assets, loans and deposits. Wide coverage, spread out in remote areas of Indonesia.	Managing Indonesia's main international gateway and is also the busiest airport in Indonesia.	Increasing economic growth through developing the Indonesian heritage tourism sector.	As a state-owned holding company operating in the pharmaceutical sector, it has an important role in ensuring the availability and independence of health products in Indonesia.

3.1.1. Innovation journey and process governance

The innovation journey of case A and B was intensive and has been organized since 2016, while case C has not been arranged systematically. Case D started in 2014 intensively. The case A with intensive innovation journey experienced innovation management in specific units (Embrio Units) and special division related to innovation management. While for case C, there are no officially organized innovation management procedures yet. Case D although the most recent case, it has started with new innovation digitization process that has been emphasized in 2021. On the innovation performance level, case A and case B show different effectiveness. In case A, the innovation process and results are quite good even though they are considered not to be running optimally while in case B the innovation performance did not significantly influence the company's business performance. It is not possible to measure the innovation performance for case C without good innovation management. This is highlighted by the source from Ministry of SOEs. For the fourth case, although the most recent in applying innovation management, the innovation process and results are quite good, although it is considered not to be running optimally because most of it is still internal.

Each case has launched and operated its innovative products (to some extent) such as banking satellite (as the world's first banking satellite), intensive smart airport and integrated Airport Operation Control Center (AOCC), online ticketing and cashless payment for domestic and foreign tourists, and real time polymerase chain reaction.

The SOEs have faced innovation barriers and challenges. Despite the implementation of innovation management, they experienced many ideas that cannot be realized, new products that are only generated by the business owner and are not supported by adequate team capabilities. The company A face challenges in becoming the leader in banking innovation. While case A experienced lack of innovation capabilities, case B experienced lack of collaboration policy implementation and limited resource as well as network allocation and capabilities. Case D on the other hand has to deal with highly regulated environment (Ministry of Health and National agency of drug and food control) in order to implement various innovation initiatives. The company in Case C has faced more challenges concerning passivity regarding welcoming ideas or innovations from outside the company.

The ecosystem with whom the SOEs interact does matter. Trasobares and Luna (2020) proposed that with more interaction and relationship with university, industry, and government, the higher the business innovation resulted in the company. The relationship can be described as follows.

3.1.2. Synergy with universities

In the context of emerging countries, empirical study has shown that knowledge transfer between universities and companies will bring positive contribution to the innovation and long-term firm performance (De Fuentes and Dutrenit, 2012). However, mostly interaction and collaboration between SOEs with universities is still lacking. SOEs in case A, B, and C show lack of active collaboration. Case A only interacted with universities during product evaluation process, while case B and case C were still planning to develop collaboration with universities. On the other hand,

company case D has started to collaborate with universities when responding to the Covid-19 pandemic.

3.1.3. Relations with industries

Compared to the past condition where big companies usually depend on internal R&D to create product and services (closed innovation), awareness of open innovation that breakthrough traditional organization limitation is getting higher (Yun and Liu, 2019). In case A, the company already had direction/plan to develop integrated innovation hub with other SOEs and companies. SOE B and C still perceived that collaboration with other companies is a transactional relationship (vendor and technology providers). However, SOE in case D has already shown progress for digitization to facilitate collaboration with other companies.

3.1.4. Roles and relationship with government

State-owned enterprises ecosystem in Indonesia has its own uniqueness in the complexity of stakeholder relationship, especially while dealing with strategic mission or public services from the government. Government could have role to promote innovation in a business environment or become inhibitor in the innovation process (Vega et al., 2012). The government, through its financial agency, is considered to have positive role in the Case A by helping licensing process easier when releasing new products. While in case B and C is considered limited as shareholder with the orientation towards operational and financial performance. On the case D, collaboration process that occurred is in the form of supervision or screening from Ministry of health and strategic direction from Ministry of SOEs.

3.1.5. Active role of society

Public participation in innovation process is growing due to development of information and communication technology that enables people to be more active in society. In addition to that, society together with industry, university and government is actively contribute to the value co-creation (Yun and Liu, 2019). Consumers have been actively involved in product development and starting from the beginning of innovation process. However, mostly SOEs were not yet actively promote involvement of user in the innovation process. Findings in SOE A and SOE D showed that the community has been involved starting from the customer validation process; the needs of consumers have always been a source of innovation, although they have not been actively involved in the process. While in SOE B and C, passengers and consumers have not been actively engaged. Customer feedback is recorded as an input to the innovation validation and evaluation process in SOE B, and SOE C tends only to respond to bad review or complaint.

3.2. Data analysis and results

3.2.1. Measurement model testing

Measurement model testing needs to be conducted first to ensure that a well-specified measurement model is required before conducting structural model analysis (Anderson and Gerbing, 1982). Measurement model testing in SEM-PLS consists of convergent validity and discriminant validity. Convergence validity assesses the consistency in measurement conducted through the operationalization of instrument

items in measuring the intended constructs (Chin, 2010). Convergence validity testing is done at both the indicator and variable levels. Convergence validity at the indicator level (indicator reliability) can be considered sufficient if the justification of an indicator to its latent variable (outer loading) is at least 0.7 (Fornell et al., 1982). Convergence validity at the latent variable level is also referred to as internal consistency (or composite reliability). Another method to test internal consistency is through the Cronbach's alpha value with a minimum value of 0.7 (George and Mallery, 2003).

The result of outer loading for all reflective indikator in this model is higher than 0.744 (IPR4). Therefore, all outer loading is considered valid. Formative indikator outer model testing uses outerweight and variance inflation factor (Hair et al., 2017). The result of outer weight of variable IE and BMI are significant and all VIF < 5, thus it is also valid.

Cronbach's Alpha value of each variable/dimension in **Table 4** below is greater than 0.7, therefore it can be stated that the sub-variables and dimensions used in the variables IE (Innovation Ecosystem), SC (Sensing Capability), IS (Innovation Strategy), BMI (Business Model Innovation), and CA (Collaborative Advantage) have an acceptable level of reliability. For the composite reliability value of each one used is greater than 0.7, then these sub-variables and dimensions are considered to have high reliability. All values of Average Variance Extracted (AVE) in **Table 4** are greater than 0.5, thus meeting the minimum required value for the convergence validity of a construct (Wetzels, et al., 2009).

Table 4. Cronbach's alpha, composite reliability and AVE results.

Variable	Sub Variable	Dimension	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
IE	GS	FBE	0.759	0.862	0.676
		IBP	0.802	0.871	0.628
		ISR	0.766	0.865	0.681
		IPR	0.856	0.903	0.702
	CI	TSC	0.723	0.844	0.643
		FINC	0.731	0.848	0.651
		FIMC	0.779	0.858	0.602
		TSO	0.743	0.854	0.661
	CUSR	FUCC	0.801	0.883	0.716
		FUSC	0.807	0.886	0.722
	CUNV	SUIC	0.845	0.906	0.764
		RUG	0.851	0.91	0.772
		CUG	0.868	0.919	0.791
SC			0.879	0.912	0.675
IS	CCIPR		0.891	0.932	0.822
	RDRR		0.904	0.94	0.839
	ICR		0.897	0.936	0.83

Table 4. (*Continued*).

Variable	Sub Variable	Dimension	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
BMI	VCRI	NCB	0.813	0.889	0.728
		NT	0.743	0.854	0.661
		NPN	0.817	0.88	0.647
		NPC	0.748	0.856	0.665
	VPI	NO	0.809	0.887	0.723
		NCM	0.825	0.896	0.741
		NC	0.819	0.892	0.734
		NCR	0.792	0.878	0.707
	VCAI	NRM	0.857	0.904	0.701
		NCS	0.865	0.908	0.712
CA	PE		0.815	0.878	0.643
	OF		0.843	0.894	0.679
	BS		0.845	0.896	0.683
	QL		0.859	0.905	0.704
	IN		0.837	0.892	0.673

Notes: Accepted if AVE > 0.5, CR and CA > 0.7 (reliability).

Discriminant validity can also be assessed by comparing the square root of the average variance extracted (AVE) with the correlation of one variable with other variables. Discriminant validity will be considered adequate if the square root of the AVE of one variable is greater than its correlation with all other latent variables (Fornell-Larcker, 1981). Discriminant validity were also tested using multitrait-multimethod matrix (HTMT) value < 0.9. Crossloading each indicator were checked, and all the result concludes that discriminant validity is accepted.

3.2.2. Structural model testing

Once the measurement model testing (outer model) results meet the criteria, the analysis of the structural model (inner model) can proceed. Several tests need to be evaluated, such as whether a Standardized Root Mean Square Residual (SRMR) value below 0.08 denotes a good model fit, as explained by Hair et al. (2021). The SRMR value of 0.076 obtained indicates an acceptable fit (<0.08), suggesting that the collected empirical data can elucidate the predicted effects between variables in the research model. The calculated R^2 values for each construct are as follows: SC = 0.699; IS = 0.487; BMI = 0.988; and CA = 0.639. A higher R^2 value signifies a better model fit to the data (Hair et al., 2019). The Q^2 value, derived from R^2 or coefficient determination, was found to be 0.999. A Q^2 value above zero implies that the exogenous latent variables have predictive relevance for the affected endogenous latent variables, as discussed by Pedhazur (1982) and Hair et al. (2019). The coefficient paths for the structural model below in **Figure 6** were calculated using the bootstrapping function in SmartPLS 4 with 500 subsamples.

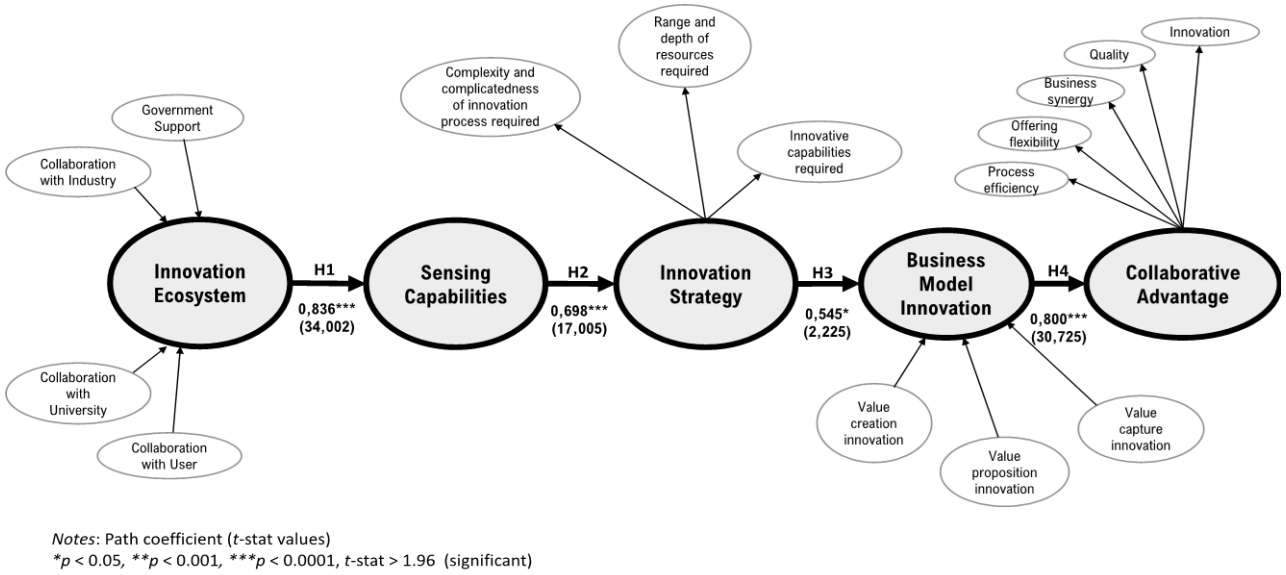

Figure 6. Hypothesis testing results.

3.2.3. Hypothesis testing

Based on the results of the analysis presented in **Table 5**, it was determined that the variable IE (Innovation Ecosystem) exhibited a positive and statistically significant impact on the variable SC (Sensing Capabilities), as evidenced by a *T* value exceeding that of the *z* score (34.002 > 1.960) and *p*-values of 0.000 < 0.050. A positive coefficient denotes that an increase in the Innovation Ecosystem can lead to a substantial enhancement in Sensing Capabilities.

Table 5. Direct correlation results by using t-statistics.

Relationship	Path Coefficient	*T* statistics	*P*-values	Description
IE → SC	0.836	34.002	0.000	Significant
SC → IS	0.698	17.005	0.000	Significant
IS → BMI	0.545	2.225	0.027	Significant
BMI → CA	0.800	30.725	0.000	Significant

Furthermore, the variable SC (Sensing Capabilities) demonstrated a positive and significant influence on the variable IS (Innovation Strategy), with a *T* statistics value surpassing that of the *z* score (17.005 > 1.960) and *p*-values of 0.000 < 0.050. A positive coefficient signifies that elevating Sensing Capabilities can effectively enhance Innovation Strategy. Subsequently, the variable IS (Innovation Strategy) displayed a positive and significant impact on the variable BMI (Business Model Innovation), with a *T*-value greater than the *z* score (2.225 > 1.960) and *p*-values of 0.027 < 0.050. A positive coefficient suggests that augmenting Innovation Strategy can notably boost Business Model Innovation.

Lastly, the variable BMI (Business Model Innovation) exhibited a positive and significant effect on the variable CA (Collaborative Advantage), with a *T* statistics value greater than the *z* score (30.725 > 1.960) and *p*-values of 0.000 < 0.050. A positive coefficient signifies that enhancing Business Model Innovation can

substantially increase Collaborative Advantage. Consequently, all hypotheses articulated in this investigation are deemed valid.

4. Discussion

4.1. The relationship between innovation ecosystem and sensing capabilities

The relationship between the Innovation Ecosystem (IE) and Sensing Capabilities (SC) has been analyzed, revealing a significant positive correlation between them. The statistical testing results for hypothesis 1 conclude that the more conducive the interaction between state-owned enterprises and Government, Industry, University, and Society, the stronger the ability of SOEs to identify innovation opportunities from their environment. It is found that the influence of the Innovation Ecosystem (IE) on Sensing Capabilities (SC) shows a *T*-statistic of 34.002 with *p*-values of 0.000. The path coefficient value of 0.836 with a positive sign indicates a positive and one-way influence between the Innovation Ecosystem and Sensing Capabilities in SOE companies and/or their subsidiaries. In other words, an improvement or enhancement in the perceived innovation ecosystem conditions by the respondents regarding their companies will lead to an increase in the ability to identify innovation opportunities within their companies. This finding aligns with Sapienza and Davidsson's (2006) research, stating that the Innovation Ecosystem positively affects Sensing Capabilities. This finding confirms that a strong innovative environment, consisting of complex networks and relationships, can influence an entity's ability to capture, analyze, and respond to information from its surroundings more effectively.

Based on the outcomes of the formative outer model measurement, it can be deduced that GS, representing the government's support for fostering sustainable innovation (Link and Scott, 2010), is the most influential aspect in the latent variable IE (Outerweight 0.306, VIF 3.916), followed by Collaboration with Industry (Outerweight 0.277, VIF 4.488) and Collaboration with University (Outerweight 0.266, VIF 3.843). This aligns with the findings of Bremmer (2009) and Guerrero and Urbano (2016), emphasizing the significance of government support and policies in shaping the innovation ecosystem of developing nations. This is also consistent with Liu et al.'s (2021) research, stating that the Government plays a significant role in encouraging state-owned enterprises to actively participate in innovation development in the PRC. Moreover, as a major stakeholder, the Government has the authority to provide policies, both encouraging and inhibiting innovation development directions, through various interventions it can make.

In this study, Government support mainly manifests through innovation policy and regulation (IPR) and infrastructure and business platform (IBP), followed by favorable business environment (FBE) and investment in scientific research (ISR). Hence, it can be inferred that the Government plays a pivotal role as an innovation catalyst by facilitating innovation ease through the formulation of innovation-related policies/regulations, both in regulatory and shareholder capacities within SOEs. **Table**

6 show latent variable innovation ecosystem and its dimension according to its outerweight and loading factors.

Table 6. Variable innovation ecosystem and its detailed dimension.

Construct/Variable	Dimension—Actors	Dimension—Role/activities
Innovation Ecosystem	Government Support	Innovation Policy and Regulation Infrastructure and business platform Investment in scientific research Favorable business environment
	Collaboration with Industry	Firm intermediary cooperation Interfirm cooperation Technology scouting Technology sourcing
	Collaboration with University	Firm-university-institute cooperation Relational university governance Contractual university governance.
	Collaboration with Society	Firm-user co-creation Firm-society interaction

4.2. The relationship between sensing capabilities and innovation strategy

From the data analysis, it can be concluded that sensing capabilities have a substantial influence on innovation strategy. it is found that the influence of Sensing Capabilities (SC) on Innovation Strategy (IS) is indicated by a *T*-statistic of 17.005 with a *p*-value of 0.000 (significant). The positive sign the path coefficient of 0.698 indicates a positive and one-way influence between Sensing Capabilities (SC) and Innovation Strategy (IS) in SOEs. In other words, an improvement in sensing capabilities to recognize changes or emerging trends in the external environment will lead to an increase in the ability to provide information on and design proactive and effective innovation strategies. Sensing capabilities enable organizations to be more responsive to changes in the market, industry trends, and customer needs, which can then shape more effective and adaptive innovation strategies. In the context of state-owned enterprises, an innovation-oriented strategy directed towards the innovation ecosystem will lead the company to actively collaborate with actors within the ecosystem, leverage available resources and knowledge, and build strong strategic positioning. Thus, sensing capabilities become key in assisting SOEs to identify innovation opportunities, respond to market changes, and collaborate with various stakeholders within their ecosystem.

The information obtained through this sensing process then becomes input for the innovation strategy formulation stage, as the first part of resource orchestration (Sirmon et al., 2011) and the seizing capabilities of dynamic capabilities. Strategy is a commitment to a coherent and mutually reinforcing set of policies or behaviors aimed at achieving specific competitive goals (Pisano, 1997). Innovation strategy addresses how innovation will create value for potential customers, how the company will capture part of that value, and what types of innovation should be pursued. Innovation strategy will guide decisions on how technology and resources are used to meet the company's targets by innovating and thus creating value and building competitiveness (Dodgson, 2008).

Furthermore, Dodgson (2008) classifies that a company's innovation strategy is considered proactive when the values of CCIPR, RDRR, and ICR are higher, and vice versa (passive). The distribution of respondents in **Figure 7** shows that the majority of SOEs relatively demonstrate the adoption towards proactive innovation strategies.

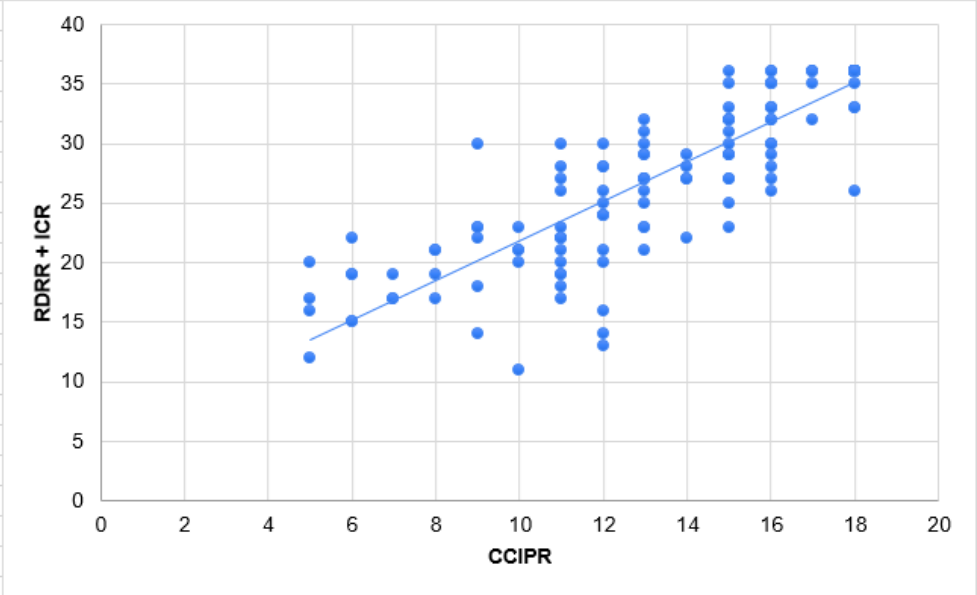

Figure 7. Indonesia SOEs mapping according to RDRR, ICR, and CCIPR in Innovation Strategy.

4.3. The relationship between innovation strategy and business model innovation

The data analysis presented indicates a significant positive relationship between Innovation Strategy (IS) and Business Model Innovation (BMI). The statistical testing results for hypothesis 3 conclude that the more proactive the type of innovation strategy of state-owned enterprises, the more innovative the business model implemented by them. It is found that the influence of Innovation Strategy (IS) on Business Model Innovation (BMI) is indicated by a *T*-statistic of 2.225 with a *p*-value of 0.027. The positive sign of the path coefficient of 0.545 indicates a positive and one-way influence between Innovation Strategy and Business Model Innovation in SOE companies and/or their subsidiaries. In other words, an improvement in the Innovation Strategy perceived by the research respondents regarding their companies will have a positive implication on Business Model Innovation. This finding is consistent with Liu et al. (2012) research, which states that a higher emphasis on innovation strategy often leads to a greater management orientation and focus on business model innovation. Companies prioritizing innovation strategies are more likely to explore and implement new business models in response to changes in market conditions and to create competitive advantages.

Thus, it can be concluded that the significant positive relationship between IS and BMI, as well as between BMI and CA, emphasizes the importance of innovation strategy in shaping the foundation for business model innovation and collaborative advantage within organizations, especially in the context of state-owned enterprises. Business model innovation could become a primary focus for SOEs since developing

new products and services is often more challenging. The Economist Intelligence Unit (EIU) survey suggests that senior managers are more interested in business model innovation than in new product or service innovation (Amit and Zott, 2012).

Furthermore, from the results of the formative outer model measurement of the Business Model Innovation variable in previous **Table 5**, it can be concluded that VPI (Value Proposition Innovation), which indicates that the company has a new business model to create innovative propositions, is the most dominant dimension in the latent variable Business Model Innovation with a loading factor value of 0.882 (valid). Value Proposition (delivery) Innovation in the context of Business Model Innovation is about modifying or completely redesigning how a company delivers value propositions to its customers. This is a fundamental marketing aspect of a company's business model and is a critical area for innovation. Value Proposition Innovation is crucial as it directly influences why customers will choose one company's offering over another. It is important for SOEs to deeply understand their customers to innovate effectively in this area. An innovative value proposition can be the basis for successful business model transformation and can help the company differentiate itself in the competitive market (Xiao and Qu, 2016). It is followed by value capture innovation (VCAI) and value creation innovation (VCRI). **Table 7** below displays its detailed dimensions according to their order of influence in the construction of BMI formative variable in the context of Indonesia SOEs.

Table 7. Variable business model innovation and its detailed dimension.

Construct	Dimensions/Type of innovation	Dimensions/Initiatives
BMI (Business Model Innovation)	VPI (Value proposition/delivery innovation)	NCR (New Customer Relationships)
		NCM (New Customers and Markets)
		NO (New Offerings)
	VCAI (Value capture innovation)	NC (New Channels)
		NCS (New Cost Structures)
		NRM (New Revenue Models)
	VCRI (Value creation innovation)	NPN (New Partnerships)
		NT (New Technology/ equipment)
		NCB (New Capabilities)
		NPC (New Processes)

4.4. The relationship between business model innovation and collaborative advantage

The statistical testing results for hypothesis 4 conclude that the more innovative the business model of state-owned enterprises, the higher the performance or advantages of collaboration of SOEs with its ecosystem actors. It is found that the influence of Business Model Innovation on Collaborative Advantage is indicated by a *T*-statistic of 30.725 with a *p*-value of 0.000 (significant). The positive sign of the path coefficient of 0.800 indicates a positive and one-way influence between Business Model Innovation and Collaborative Advantage in SOEs. The positive coefficient in the relationship between BMI and CA confirms that an increase in business model innovation can effectively enhance collaborative advantage within organizations.

Thus, it can be concluded that state-owned enterprises (SOEs) capable of developing innovative business models have the potential to strengthen collaborative relationships with various external stakeholders, such as industries, universities, and governments.

Furthermore, from the results of the outer model measurement of the Collaborative Advantage variable in previous **Table 5**, it can be concluded that PE (process efficiency), which indicates to what extent SOEs collaborates with partners to create efficient business processes, is the most dominant dimension in the latent variable Collaborative Advantage with a loading factor value of 0.908 (valid). This can be explained considering the conventional perception of SOEs towards collaboration influenced by the "outsourcing" mindset that leads to the mission of the need for process efficiency. Collaborative advantage essentially has broader benefits referring to an organization's ability to gain competitive advantage by collaborating with other entities beyond what can be achieved individually. This concept acknowledges that by leveraging the unique capabilities and resources of multiple organizations, they can achieve results that would not be possible if they acted alone (Porter, 1985). For example, through collaboration, organizations can combine their resources, share knowledge and expertise, access new markets, and innovate more effectively (Huxham and Vangen, 2004). In the realm of business strategy, organizations often seek ways to gain an advantage over their competitors (Hadj, 2020). Traditional competitive advantages are based on factors such as assets, position, and economies of scale. However, in recent times, there has been a shift towards a new concept known as collaborative advantage. Other dimensions that can reflect collaborative advantage besides PE in sequence are QL (quality), IN (innovation), OF (offering flexibility), and BS (business synergy).

Table 8. Variable collaborative advantage and its detailed dimension.

Construct	Dimension	
CA (Collaborative Advantage)	PE (Process efficiency)	Showing to what extent the collaboration of state-owned enterprises with partners can create efficient business processes.
	QL (Quality)	Demonstrating the extent to which state-owned enterprises and partners offer reliable and durable products, thereby creating higher value for customers
	IN (Innovation)	Showing the extent to which state-owned enterprises collaborate with partners in introducing innovative processes, products, or services.
	OF (Offering flexibility)	Demonstrating the extent to which the relationship between state-owned enterprises and their partners supports changes in the products or services available to customers
	BS (Business synergy)	Showing the extent to which partners are able to combine complementary and related resources to achieve additional benefit

4.5. Theoretical contribution

This research aims to contribute to the accumulation of knowledge in the field of strategic management and innovation, especially for the SOEs. The first theoretical contribution is to the literature of innovation ecosystem, especially in the context of SOEs in developing countries. It provides empirical evidence on what are the actors and roles that form innovation ecosystem in SOEs and its effect in the innovation process. As an initial step to compose comprehensive innovation ecosystem model, the Innovation Ecosystem referred to is a micro-level ecosystem centered around innovation subjects such as companies, research/educational institutions, and others, also known as enterprise innovation ecosystem (Feng et al., 2021; Jiang et al., 2019), with SOEs as the focal firm (Adner and Kapoor, 2010). In accordance with Yun and Liu's research (2019), innovation ecosystems as an open innovation practice can consist of collaboration and interaction among actors in the quadruple helix, namely industry, universities, government, and society. In the context of SOEs in Indonesia, it is important to understand the innovation ecosystem as Enterprise Innovation Ecosystems (EIEs). This indicates that SOEs are the main focus within this ecosystem and interact with various other actors. The innovation ecosystem of SOEs is formed through collaborative innovation involving various external parties such as universities, startups, and other established players. Empirically from the research data testing, it can be concluded that government support has the greatest role in strengthening the innovation ecosystem, followed by collaboration with industry, collaboration with universities, and collaboration with society. The government plays a crucial role in initiating and facilitating the innovation ecosystem, especially through public projects and national policies. In managing the innovation ecosystem, open innovation becomes key, with SOEs actively orchestrating innovation collaborations beyond their corporate boundaries. In the overall context, a deep understanding of the innovation ecosystem is crucial to strengthen competitiveness and sustainable growth for SOEs and the overall business ecosystem.

This study also contributes theoretically by enriching strategic entrepreneurship processes (Hitt et al., 2011) by incorporating innovation ecosystem as environmental factors which affects the overall process of SEP and integrated innovation process within it. Innovation ecosystem can be seen as an environmental factor and an external resource that influences opportunity seeking activities (OSA) and Advantage seeking activities (ASA). This research confirms that the input-process-output model integrates environmental influences into the strategic entrepreneurship process according to Hitt et al. (2011) by developing a consistent flow of innovation. While Utoyo (2019) explained that collaborative innovation should be done separately from SOEs internal core innovation capabilities due to their different natures of innovation speed and core rigidity, this study argues that collaborative innovation in the innovation ecosystem should be started in the exploration phase. The innovation ecosystem has a direct impact on sensing capabilities as input for seeking new innovation opportunities (OSA). Operationalization of resource orchestration in this study is conducted by innovation strategy and ecosystem-oriented business model innovation (ASA). Business model innovation can be seen as a process in reconfiguring and an indicator of innovation performance output. It also supports

Vicky et al. (2017) that argues the importance of innovation strategy in improving business models to collaborate innovatively and gain collaborative advantages within an ecosystem.

Lastly, this research also supports perspective of collaborative advantage as a proxy of competitive advantages in the context of business and innovation ecosystem. Collaborative advantage encompasses the ability to form effective and rewarding partnerships with other organizations (mutually beneficial) (Kanter, 1994, 2012). The ability to create and sustain such productive collaborations will provide significant competitive advantages. The ecosystem level of analysis and business model emphasize partnerships/interactions among mutually influencing actors, thus making Collaborative Advantage a better fit to describe the jointly achieved benefits. Traditional competitive advantage focuses on competition among companies to win market share by differentiating themselves from competitors. However, in this increasingly interconnected and complex era, collaboration between companies is becoming more important. This study support that while traditional competitive advantage remains relevant, collaborative advantage can provide additional benefits, such as access to additional resources and competencies, lower risk in product development or expansion into new markets, and the ability to innovate more quickly and effectively through cross-functional and cross-company engagement (Pradabwong et al., 2017; Vangen and Huxham, 2003). Thus, the shift to collaborative advantage reflects recognition that in an increasingly complex and interconnected economy, cooperation between companies can be key to creating sustainable value and gaining mutual advantage. This research is conducted with the understanding that collaborative advantage more accurately represents competitive advantage in the context of the innovation ecosystem.

Empirical evidence in this research indicates and supports that BMI plays significant role for achieving collaborative advantage for SOEs and their actors in the innovation ecosystem. Business model innovation is crucial, yet the theory of business model innovation remains scarce and intellectually underexplored (Teece, 2010). An effective business model serves as the core enabler of all company performance. BMI not only becomes more important due to increasing global competition but also presents significant theoretical and practical challenges. From the statistical testing of the data obtained, this study also implies that the internal perception of state-owned enterprises regarding the level of business model innovation still needs improvement. Schneider and Spieth (2013) also elaborate that business model innovation can be seen as the company's response to changes in value creation sources. Business model innovation requires companies to consider uncertainty in their environment as potential opportunities that need to be explored and exploited (Hitt et al., 2001; Ireland and Hitt, 1999). Although a company may already have a well-established and smoothly running current business model, it still needs to explore potential opportunities in its environment, exploit them, and reap maximum benefits (Schneider and Spieth, 2013). Strategic entrepreneurship emphasizes the need to detect early and recognize these opportunities and challenges (Ireland and Webb, 2007, 2009; Ketchen et al., 2007). In this open innovation ecosystem model for SOEs, BMI can be seen as a mechanism in orchestrating innovation processes that complement the company's

strategy, in the form of a system of business activities conducted jointly with ecosystem partners to create value, innovate, and meet consumer needs.

4.6. Managerial implication

Understanding the role of the business innovation ecosystem in the overall integrated innovation process of SOEs is expected to contribute to the strategic initiatives to develop capabilities in managing interaction and collaboration with actors in the innovation ecosystem so that it can increase the success and effectiveness of the innovation process in SOEs, and can lead to a framework innovation collaboration that is more efficient, effective, lower risk and opens up opportunities to work with the parties involved. The practical implications of this research highlight the need for organizations to focus on innovation ecosystems to enhance their opportunity seeking activities (OSA) and advantage seeking activities (ASA).

First implication is that SOEs managers needs to formulate policies and governance for innovation, to orchestrate the actors in fostering a conducive innovation ecosystem through a more comprehensive understanding of the open innovation ecosystem model for SOEs. Innovation ecosystem model for SOEs derived from this research is a derivative of the integration of the conceptual framework of the quadruple-helix, open innovation (Yun and Liu, 2019), and input-process-output strategic entrepreneurship (Hitt et al., 2011). The open innovation ecosystem model discussed in this study emphasizes the importance of collaboration and interaction between state-owned enterprises as the focal firm and its ecosystem actors. Therefore, various policies and strategies are needed to encourage conducive interaction and collaboration among them. SOEs managers needs to develop strategies, programs, and governance that enhance interaction and collaboration with ecosystem actors to leverage the innovation ecosystem to strengthen its innovation exploration capabilities. SOEs managers needs to formulate and adopt proactive innovation strategies in its long-term strategic plans to seize innovation opportunities in the continually evolving innovation ecosystem.

The second implication, SOEs managers needs to increase attention and efforts in developing innovative ecosystem-based business models as part of operationalizing its innovation strategy. By integrating innovation strategies and business model innovation, companies can effectively leverage their resources and capabilities to adapt and thrive within the innovation ecosystem (Dereli, 2015). In doing so, they can create new value for their customers, differentiate themselves from competitors, and capture growth opportunities in ever-changing markets (Boons et al., 2013). State-Owned Enterprises will be in a strong position as champions within their ecosystems, capable of sustaining their innovation processes and playing a central role in capturing value within their ecosystems, if they are: 1) open to new opportunities, 2) agile in adapting innovations to meet customer needs, and 3) proactive and systematic in their approach to identifying potential risks (Madsen, 2019).

The third implication, SOEs managers needs to change paradigms to pursue collaborative advantage as a proxy for competitive advantage in the context of the innovation ecosystem. Collaborative advantage and competitive advantage are important concepts in strategic management, but they have different goals and

relevance depending on specific contexts and objectives. Collaborative advantage may be more appropriate than competitive advantage in certain situations, including: more innovation and creativity needed, access to rare resources and capabilities, flexibility and adaptability, better risk management, and working together for sustainability and shared value.

Finally, the government, as the regulatory and shareholder of SOEs, needs to create policies and regulations that support innovation, innovation infrastructure and platforms, a comfortable and rewarding innovation environment, as well as investment support in the development of science and technology. This may include tax incentives for investment in research and development, streamlining licensing processes for innovative projects, risk management, strategic planning and allocation of investment/resources for innovation, and enhancing intellectual property rights protection.

In the overall context, a deep understanding of the innovation ecosystem is crucial to strengthen competitiveness and sustainable growth for SOEs and the overall business ecosystem.

5. Conclusion

This research aims to explore and propose the SOEs innovation ecosystem model which is expected to contribute to the nation's economy by increasing innovation performance, competitiveness, growth, and national resilience. The innovation ecosystem model of state-owned enterprises consists of government support, which plays the most significant role in strengthening the innovation ecosystem, followed by collaboration with industry, collaboration with universities, and collaboration with society.

The conducive interaction between SOEs and the government, industry, universities, and society (innovation ecosystem) has a direct impact on strengthening the SOE's ability to identify innovation opportunities from its environment (sensing capabilities). Thus, the innovation ecosystem has both direct and indirect impacts on orchestrating innovation processes in SOEs. The sensing capabilities of SOE will influence the innovation strategies chosen by them. SOEs with strong sensing capabilities will consequently improve their ability to provide information and design proactive and effective innovation strategies. Integrated orchestration of innovation processes in SOEs through innovation strategy instruments and business model innovation will have a positive impact on collaborative advantage. Business model innovation serves as an appropriate instrument in integrating internal and external resources and capabilities to obtain collaborative advantage in the business ecosystem context. The relatively low average of the BMI variable indicates a focus on room for improvement for SOE's management. Finally, by building collaboration with other actors through the right business model on how to do the business and develop innovation has significant role to increase SOE's collaborative advantage, which considered as a proxy for competitiveness of Indonesia SOEs.

However, this research limits the discussion to the impact of the innovation ecosystem on the orchestration of internal innovation processes carried out by SOEs, especially business model innovation as one form of innovation. As large companies,

SOEs are generally accustomed to and have expertise in managing their internal innovations. Meanwhile, the role of the innovation ecosystem as an environmental factor and the impact of interactions between actors in the ecosystem on the innovation process are things that still need to be explored and are a limitation of the scope of this research. The developed model is a simplification of the conditions and relationships between actors and processes in the integrated innovation process in state-owned enterprises in a linear manner. Considering that the nature of the innovation process in reality is highly dynamic, nonlinear, and interconnected, thus the system dynamics approach becomes more appropriate in depicting the dynamics of the innovation system. This allows for a more holistic, complex representation of relationships that influence each other, facilitate feedback loops, account for delay effects, and enable long-term planning through simulation and integration of data.

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