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Symbiotic Relationships in Business Ecosystem: A Systematic Literature Review

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Abstract: The business ecosystem shares many unique features with the biological ecosystem due to its origins. Similar to the biological ecosystem, the business ecosystem also emphasizes symbiotic relationships among symbionts (i.e., participants of a business ecosystem). In this study, we have broadened and deepened our knowledge of symbiosis in a business ecosystem, focusing on how each relationship develops and evolves through the interaction between keystone species and symbionts. We have introduced the typology of symbiotic relationships and highlighted the significant role of keystone species in business ecosystems. We defined three symbiosis types based on the analysis results: mutualism, commensalism, and parasitism. The findings indicated that each relationship continuously transitions into different symbiotic relationships as the relationship between the participants changes. The results also showed that a keystone species, a leader of a business ecosystem, can contribute to the success of a business ecosystem by strategically managing their relationship with symbionts.

Keywords: business ecosystem; business symbiosis; symbiotic relationship; mutualism; commensalism; parasitism; business platform

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1. Introduction

The increased pace of technological advancements has changed the competitive landscape in the market by increasing the necessity of cooperation with other participants to create value [1,2]. A complicated business environment, dynamic technological advancements, and the changing shape of competition in the market have meant that it is crucial to understand a business as a complex of organizational entities and its network [3,4]. The business ecosystem concept has received attention from entrepreneurs and academics since the early 1990s [2,5]. The introduction of business ecosystems is founded in the similarities between nature and business fields [5,6]. For example, key natural phenomena, such as prey-and-predator, cooperation, competition, and growth, are also observed in business fields [6].

Furthermore, a business ecosystem shares many features with the biological ecosystem in terms of the concept of survival and evolution [7]. Business ecosystems aim to establish a sustainable business through co-evolution based on the complementary relationships between participants [8,9]. Considering that participants in a business ecosystem can benefit from co-evolution, it is essential to examine and understand the relationships between participants in a business ecosystem. Among various participants, business platforms, such as Amazon and Apple, have received much attention from both academicians and entrepreneurs due to the industry-wide influence that these platform providers have [2,10,11]. In addition, business platforms are located at the center of a business ecosystem as they drive developments and expand specific business fields [2,12,13]. However, extant studies mainly discussed business ecosystems at a conceptual level, such as features and roles of business ecosystems, and did not pay much attention to relationships between participants and the strategic importance of business platforms for entrepreneurs [13–17].

Considering the similarities between nature and business ecosystems, the relationships between species in the biological ecosystem could aid the interpretation of the relationship between participants in a business ecosystem [13,18]. It will further extend the current understanding of the roles of participants in the symbiotic business ecosystem and support us in providing theoretical and managerial implications to the relevant fields. In this study, we investigated the symbiotic relationships of participants in a business ecosystem based on the three research questions below:

- RQ 1. What types of symbiotic relationships exist between participants in a business ecosystem?
- RQ 2. How do symbiotic relationships evolve, and how are they developed in a business ecosystem?
- RQ 3. How can participants in a business ecosystem benefit from symbiotic relationships?

Considering that research regarding symbiotic relationships in business ecosystems is still at an early stage, we conducted a systematic literature review (hereafter SLR) to explore symbiosis in business ecosystems based on extant discussions. The analysis will provide managerial implications for platform providers to help them design successful and sustainable business platforms and theoretical implications for the relevant fields.

The remainder of this study is constructed as follows. First, Section 2 discusses existing studies that focus on a business ecosystem, its participants, and the role of business platforms in a business ecosystem. Next, details of the research methodology and the data collection procedure are provided in Section 3, and the SLR results are provided in Section 4. Finally, in the last section, we discuss theoretical and business implications alongside the limitations of this study.

2. Theoretical Background

The topics of business ecosystems and symbiotic relationships between a business ecosystem's participants have received increased attention from academics and business practitioners [19]. As the term "ecosystem" implies, a business ecosystem is derived from the concept of the biological ecosystem [14,15,20,21]. This section introduces the current developments in a discussion concerning business ecosystems, their participants, and the role of the business platform in a business ecosystem.

2.1. The Emergence of the Concept of Business Ecosystem

In the past, people have taken a narrow perspective and have seen companies as rivals, and companies have focused on their resources and capabilities to compete and survive in the market [22]. The changes in how people view reciprocal relationships between companies and related business environments and the application of ecological concepts to the business world have facilitated discussions regarding business ecosystems since the late 1990s [23–26]. The term "business ecosystem" was coined by James F. Moore in 1993 [14–16]. The business ecosystem concept was inspired by the biological ecosystem, representing a community of heterogeneous species interacting with each other [2,27,28]. There are varying definitions of a business ecosystem. In consideration of the biological ecosystem, interacting organizations could be defined as a community [2,14,16,29–31].

Since the introduction of business ecosystems, the concept has received much attention from academics and practitioners [15,17]. Remarkably, the emergence of the business ecosystem concept has shifted entrepreneurs' viewpoints on competition and business strategy [2]. In addition, the introduction of the concept of the business ecosystem drew scholarly attention to three key features of a business ecosystem: platform, co-evolution, and symbiosis [26].

In the case of the business platform, platforms are frequently discussed in terms of the success of business ecosystems [32]. According to Moore's definition, participants in a business ecosystem provide their products and services on a platform [14]. Platforms can be described as frameworks or architectures that other companies in a business ecosystem can use to support their business [32,33]. The core strategy of the platform is to create

value through interactions with other companies in a business ecosystem [2,25]. Generally, platform providers hold a critical role in a business ecosystem by increasing innovation and productivity while benefitting from lock-in effects by establishing a solid foothold in the market as a dominant platform [2,10,11,34].

The term "co-evolution" originated from biology and described successive changes between two or more species that have intertwined evolutionary trajectories [35]. When it comes to business ecosystems, participants co-evolve through a recursive cycle of evolution and subsequent changes in the ecosystem [13,14,32]. For this to happen, the adaptive capability of each participant and the interactions between participants in the ecosystem is necessary [36]. Among the various participants, the keystones explained in the following subsection have significant influence over the co-evolution in a business ecosystem [13].

The term symbiosis, originating from biology, describes mutualistic relationships between participants in a business ecosystem [37,38]. In general, participants in a business ecosystem have a certain level of symbiotic relationship with other participants because competition tends to be weak between companies within the same ecosystem [26,39]. Several researchers have highlighted the symbiosis in business ecosystems with three types of symbiotic relationships: mutualism, commensalism, and parasitism [27,34,40]. These three types are classified based on the distribution of benefits between the participants in such a relationship [40].

2.2. Participants of the Business Ecosystem

Like a biological ecosystem, a business ecosystem consists of various participants, such as companies, government authorities, consumers, and competitors [30,41]. Moreover, similar to a biological ecosystem, the sustainability of a business ecosystem depends on its participants' survival [9,23]. For this reason, the participants of a business ecosystem share two goals, mutual effectiveness and survival, even though they are loosely interconnected with each other [16,18].

Among various participants, several studies suggested the taxonomies of participating companies. According to extant studies, companies can be categorized based on their position in a business ecosystem and organizational characteristics. In terms of their position in a business ecosystem, companies can be categorized into five groups: keystone species (i.e., leading species), dominant species, flagship species, hub landlords, and niche species [12,18,31,42]. Keystone species are placed at the highest position in business ecosystems, similar to predators in the food chain [43]. As leading players in a business ecosystem, the keystone species try to improve the ecosystem's overall health and determine the ecosystem's survival [6,43]. In some cases, keystone species limit the number of species or even remove some species to improve the ecosystem's health and productivity [18]. Widely known examples of keystone species in business ecosystems are Microsoft's operating system, Apple's iOS, and Google's Android mobile operating system [18,20,31].

Dominant species are distinguished from keystone species by two points: they are easily recognizable due to their physical size, and they reduce the diversity of the ecosystem by taking over other species [16,18,43]. As with keystone species, dominant species also play a central role in business ecosystems, although their size is more significant than keystone species [16,43]. Keystone species have indirect influence over the ecosystem, while dominant species aggressively take over the ecosystem by eliminating or absorbing other species to integrate horizontally or vertically to own a large proportion of the business ecosystem [18,20,43]. Examples of dominant species include IBM's computing system and Google's YouTube Music [20].

Flagship species are located in a hub position in business ecosystems [44]. The term flagship species originated from conservation biology, which defines species that receive the most popular support [44,45]. Strategic leadership is mainly provided by flagship companies with closer relationships with the participants of a business ecosystem than keystone species [44]. As a hub, flagship species play a role as a bridge between participating

companies and keystone species; however, flagship species have received little attention from researchers [44].

Similar to flagship species, hub landlords also occupy a hub position and link nodes (i.e., participating companies) around them [16,44]. Compared with flagship species, hub landlords create little or no value to the ecosystem while extracting the most value possible from nodes linked to them [16]. Compared with dominant species, hub landlords prefer to control value extraction rather than the network [46].

Niche species are neither keystone nor dominant species and have a lesser impact than keystone or dominant species [18]. Niche species are diverse and collectively make up a large portion of the ecosystem; thus, they are essential for shaping it [16,18]. In a business ecosystem, niche species make themselves attractive to other species by differentiating themselves using unique resources and capabilities [6]. The relationships between keystone and niche species are critical for the ecosystem's overall health, because niche species account for a significant portion of the ecosystem and create most of the value by forming complementary relationships with keystone species [6,16].

In terms of organizational characteristics, companies can be categorized into two groups: profit organizational species and nonprofit organizational species [47,48]. The concept of profit organizational species, derived from natural biological selection introduced by Darwin, explains each company's motive to maximize profit to survive under a competitive environment [47]. On the other hand, nonprofit organizational species consist of two types according to the revenue source: collectivist (relying on government grants or public donations) and individualist (relying on fees from members) [48].

2.3. The Role of Business Platform in Business Ecosystem

A business platform can be defined as one of the business strategies used to create value through transactions between participants [10,25,37]. In the case of the ICT sector, a platform is a framework provided by a platform owner to launch services, applications, or software [33]. Platforms have two distinctive features; one is an intermediary role in a business ecosystem, and the other is network effects [19,25,49–51]. Platforms such as Google, Apple, Facebook, and Amazon typically link consumers and product/service providers; in some cases, platforms allow consumers to simultaneously assume the role of provider and consumer [19]. As a platform's transaction volume grows, the size of the market also expands with the help of network effects [10,25,26,51].

Business platforms, located at the heart of business ecosystems, play a central role in a business ecosystem [2,6]. Extant studies regarding business ecosystems describe platform providers as hubs or keystone species to highlight the platform's central position and strong influence in business ecosystems [12,52]. Primarily, platform providers determine the overall health of a business ecosystem by leading innovation and increasing productivity [2]. In recent years, platforms have become a core foundation in many industries by shifting competition in the market and influencing business strategies and business models [35].

2.4. Research Gap in the Field of Business Ecosystem

An increasing amount of research on business ecosystems has been conducted since Moore introduced the concept. Although various participants collectively make up a business ecosystem, most studies regarding business ecosystems have only focused on partial aspects, such as the roles and activities of keystone species (i.e., established platform providers) [2,14,26,35,50]. Thus, further research highlighting the relationships between heterogeneous participants in business ecosystems is needed to develop our understanding of the nature of business ecosystems. In terms of the typology of relationships between participants, a few studies highlighted ideas regarding the typology of symbiotic relationships in business ecosystems; however, there is still much room for theoretical development. Remarkably, most extant research focused on symbiotic relationships only discussed mutual relationships. Business ecosystems have great potential to be developed and investigated

further in many different ways regarding the symbiotic characteristics and relationships of a business ecosystem.

3. Data and Research Method

This study explored the symbiotic relationships and unique features in business ecosystems. Referring to extant studies exploring the concepts and features of a specific field, we adopted a systematic literature review (hereafter referred to as SLR), which helped us aggregate existing discussions from various articles [53–57]. An SLR, also known as a systematic review, is a qualitative research method which allows a researcher to investigate a specific field based on a literature review [53,58]. There are three basic principles of SLR: reproducibility, explicitness, and transparency [58]. These three principles make up the unique characteristics of SLR. The first principle, reproducibility, means that any researcher can derive a similar result under the same research setting, such as keywords for data extraction and data sources. The second and the third principles describe the SLR process, which is clearly defined compared to a traditional literature review.

This research framework consists of four steps in analyzing extant studies: data collection, title and abstract screening, full-text screening, and analysis (see Figure 1) [53,56,57]. Firstly, we used several sources, such as Web of Science, ScienceDirect, Scopus, Springer, and snowball sampling, to collect articles, books, and conference proceedings focused on business platforms and business ecosystems to explore the concepts and features of symbiotic relationships in business ecosystems. We set the search period to range from 1993 to 2021, considering that James F. Moore first introduced the term "business ecosystem" in 1993. We retrieved documents using four keywords: business, platform, ecosystem, and symbiosis. To ensure the documents we retrieved were as relevant as possible, we separated the search keywords with commas. This allowed us to retrieve documents that contained at least one of the given keywords. Finally, we applied the keyword search and snowball sampling to include documents not extracted from databases such as WoS and Scopus. Snowball sampling is widely used in qualitative research such as SLRs and content analysis to derive data fits for research [53,58,59]. Snowball sampling is helpful for the purpose of sampling of data in the absence of a well-known data source for such data because the mechanism of snowball sampling is that desirable data can be located using the initial set of data as a clue [58]. As indicated in Table 1, we collected 826 documents from the five data sources listed below.

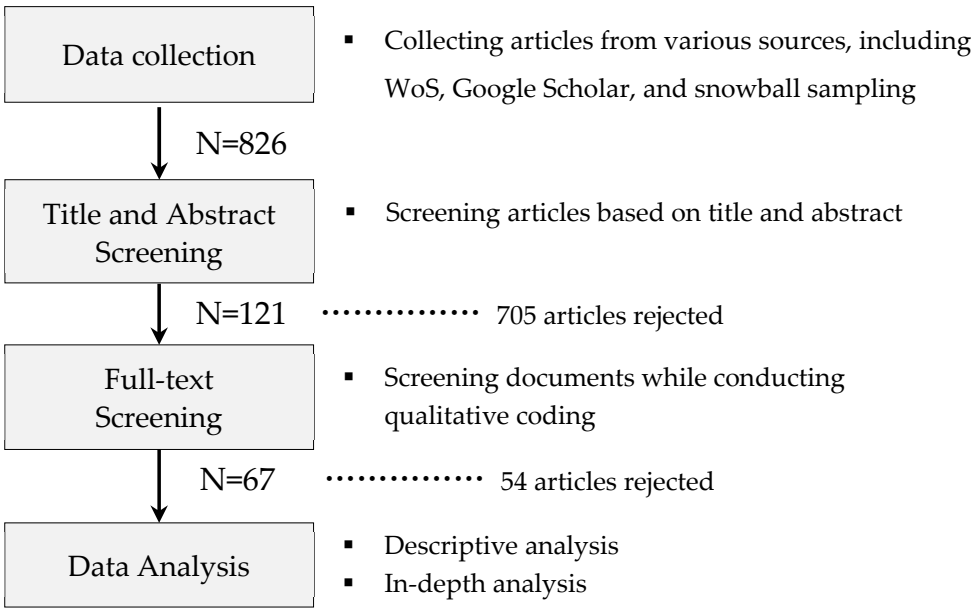

Figure 1. Research framework.

Table 1. Data sources.

Data Source	Description	Number of Documents
ScienceDirect	A database for academic journals with scientific and medical publications published by Elsevier.	499
Springer	Online subscription-based academic journal publisher provides scientific indexing services.	246
Web of Science	Provides comprehensive citation data from multiple databases by Clarivate.	10
Scopus	Database of abstracts and citations from book series and journals launched by Elsevier in 2004.	9
Snowball sampling	Snowball sampling is a purposive sampling method used to collect data using the initial data set as a lead.	62
	Sum	826

After data collection, we screened the documents to delete irrelevant documents and refine the raw data before conducting the data analysis. We refined documents based on two criteria: whether a document discussed business platforms and ecosystems and whether a document focused on the symbiotic features of a business ecosystem. We conducted two stages of screening. We first screened documents by reviewing the title and abstract, and then we screened documents while reviewing the full text while conducting qualitative coding. After the screening process, 67 documents were left for data analysis.

In this study, we used Atlas.ti 9 (Berlin, Germany), part of CAQDAS (Computer-assisted Qualitative Data Analysis Software), for data analysis. Atlas.ti 9 is influential for qualitative coding as it provides useful features such as document groups, networks, and code co-occurrence tables [53,60]. We conducted qualitative coding for the analysis of collected documents. Qualitative coding is one way of analyzing qualitative data and allows a researcher to extract meanings from data by assigning codes to a word, phrase, or paragraph [58,61]. We coded data with open coding and then categorized codes through axial coding. Open coding is an initial phase of coding that helps researchers break down data into small parts to interpret their meaning [58,62]. After open coding, we reassembled and grouped codes according to their meaning, a process called "axial coding" [58]. Based on the axial coding result, we synthesized concepts and features of business ecosystems and investigated details of symbiotic relationships in business ecosystems.

4. Systematic Review of Symbiotic Relationships in the Business Ecosystem

Section 4 is divided into three parts: descriptive analysis, symbiosis in business ecosystems, and the typology of symbiotic relationships in business ecosystems. In the first part of Section 4, we present descriptive analysis results such as the publication status, including major target journals, publication year, and research methods [63]. Next, in Section 4.2, we suggest the typology of symbiotic relationships in business ecosystems and look into the details of each symbiotic relationship. Finally, Section 4.3 provides an overview of symbiosis in business ecosystems regarding how and why a business ecosystem is formed based on the extant studies.

4.1. Descriptive Analysis

We collected various types of documents from five data sources using a keyword search and snowball sampling. As indicated in Figure 2, research regarding business ecosystems has gradually increased year by year since Moore introduced the term "business ecosystem" in 1993. As shown in Figure 2, three moments show significant increases in research focusing on the business ecosystem: the years 2003, 2011, and 2016 [6,64,65]. Firstly, the increase in the mobile network business, which was leveraged by the wide usage of cellular phones, seemed to facilitate more research interest in business ecosystems in 2003.

Mobile network business is an independent business network organized as a business ecosystem between a network provider and mobile device manufacturer to provide mobile communication [66,67]. Secondly, the expansion of the smartphone business promoted by Apple's introduction of its business ecosystem with the iPhone seemed to drive the second flow of the increase in the amount of research on business ecosystems.

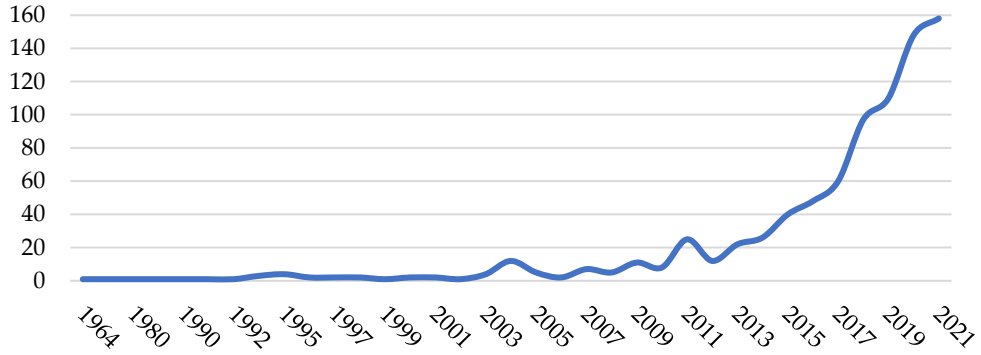

Figure 2. Increasing amount of research on business ecosystems.

Moreover, Google's Android built a smartphone business ecosystem with the smartphone manufacturer, providing the Android operating system and application marketplace [5,6,33,68–71]. Lastly, since 2015, big tech such as Facebook and Amazon have facilitated academic interest in interpreting their business ecosystem over the business platform. As a result, studies regarding business ecosystems have developed explosively as the source of business cases has widened [72–74].

Table 2 briefly summarizes data from the SLR according to data type and source. ScienceDirect and snowball sampling were the dominant sources in terms of data source, accounting for 81 percent of the total data, while the other three sources, Springer (Berlin/Heidelberg, Germany), WoS (Philadelphia, PA, USA), and Scopus (Amsterdam, The Netherlands), consisted of 19 percent of the total data. Our data ranged from peer-reviewed journal articles to working papers in terms of data type. Journal articles accounted for 76 percent of the data, and other documents such as books and conference proceedings made up the rest of the data. Different types of data help embrace multiple researchers' diverse perspectives on business ecosystems.

Table 2. Data type per source.

Data Type	Source					Sum
	Science Direct	Scopus	Springer	WoS	Snowball Sampling	
Article	26	3	5	2	14	50
Book	-	-	2	-	1	3
Conference proceeding	-	-	1	-	2	3
Dissertation	-	-	-	-	3	3
Editorial perspective	1	-	-	-	1	2
Magazine	-	-	-	-	1	1
Report	-	-	-	-	3	3
Working paper	-	-	-	-	2	2
Sum	27	3	8	2	27	67

Concerning the top-ranked journals, such as Technology Forecasting and Social Change, accounted for the most significant portion of the subjected documents (See Table 3). Following Technology Forecasting and Social Change was the Journal of Cleaner Production, Technovation, the Technology Innovation Management Review, Industrial Marketing

Management, Asian Business and Management, and the Journal of Systems and Software. Contrary to our expectations, the scope of top-ranked journals mainly focused on the technology-related field. For example, Technovation focuses on technological innovations and the management of technology.

Table 3. Top-ranked journals.

Journal	Number of Articles
Technology Forecasting and Social Change	9
Journal of Cleaner Production	5
Technovation	2
Technology Innovation Management Review	2
Industrial Marketing Management	2
Asian Business and Management	2
Journal of Systems and Software	2
Others	43

Concerning research methodology, most articles were based on qualitative research, only 14 percent were based on quantitative research, and two percent were based on a mixed method. As we highlighted in Table 4, case studies were the dominant research method among the various qualitative research methods, and SLR, which we also applied in this study, was the second most dominant research method. A striking difference between the portion of qualitative and quantitative research seems to be due to the current status of research regarding business ecosystems, which is still in an early stage [34].

Table 4. Major research methods of journal articles.

Research Methods		A Proportion of Each Method
Qualitative/Quantitative/Mixed	**Detailed Methods**	
Qualitative (84%)	Case study	34%
	SLR	26%
	Narrative review	20%
	Content analysis	2%
	Integrative review	2%
Quantitative (14%)	Survey	2%
	Logistic model	2%
	Network analysis	2%
	Regression	2%
	Others	6%
Mixed (2%)	Comparative historical Analysis + regression	2%

4.2. Typology of Symbiotic Relationships in a Business Ecosystem

In terms of a business ecosystem, symbiosis, which is a relationship between participants such as prey and predator, can be interpreted as value creation and capture of symbionts [14]. As shown in Table 5, each symbiotic relationship shows different relational properties and features.

Mutualism, a primary relationship in business cooperation, represents a successful business relationship [75,76]. Platform providers who set their own business within a business ecosystem set their goal to co-create value with participants in the business ecosystem [2,34,77]. This leads to the co-evolution of participants in a business ecosystem to gain a competitive edge in the market through the network effects of the business platform. Participants in a mutualistic relationship fully cooperate to gain value from shared customers or confront other business ecosystems [78]. Mutualism aims to evolve current participants in a business ecosystem while improving an ecosystem's overall health, which would

attract new participants and attain a competitive edge through open innovation [78,79]. In terms of business platforms, mutualism is frequently seen in contemporary platform-based ecosystems such as Airbnb and Uber, in which individuals simultaneously act as providers and consumers [19]. The value created from a mutualistic relationship between consumers and product or service providers draws more participants to such an ecosystem, eventually leading to the platform's success [26]. Therefore, a keystone species' role in facilitating cooperation between participants is essential for the platform's success by allowing value co-creation with participants while increasing the overall health of the business ecosystem [16].

Table 5. Types of symbiotic relationships.

Category	Mutualism	Commensalism	Parasitism
Definition	• Mutualistic co-evolution for cooperation and complementation [41]. • Participants gain mutual benefits from the relationship [34].	• One is benefiting while the other is being unaffected [27].	• While one is benefitting, the other is being harmed [27].
Relationship	• A participant can strengthen the other by sharing benefits (and vice versa) [27,75]. • Participants depend on each other for mutual survival [22].	• Commensalism can be observed between competitors [78].	• Supporting participants rely on keystone species to survive [34].
Features	• Fundamental mechanisms exist across different participants in the business ecosystem [27]. • Participants with mutualism can have value co-creation and business sustainability [37]. • Mutualism can promote a business ecosystem's expansion by drawing in new participants, increasing species diversity [40].	• Commensalism can include cooperation; thus, the value between participants can be partially overlapped [78].	• The keystone species' growth is hindered because they support participants' resource consumption [34].

Commensalism is a relationship based on the unconscious transactions of positive influences to the beneficiary since keystone species are unaffected by the beneficiary [80]. Concerning cooperation between participants, commensalism can be viewed as benefitting from the residual outcome of keystone species [78,81]. When commensalism emerges in the cooperation between participants, the value can be partially overlapped between participants [78,82]. For example, in terms of the video game industry, game companies such as Nintendo, Sony, and Microsoft struggle to build their own business ecosystem with game software producers to provide various game content for consumers. In order to do so, game companies need to invest in game software producers to resolve the deficiency in game content at an early stage of business [51].

Parasitism is deemed to hardly belong to the "symbiotic relationship" category as one participant harms the other [83]. Instead, parasite participants rely on a parasitic relationship to keep their survival activities and be competitive in the market [34]. The parasitism can result in an unexpected outcome such as the death of participants or co-evolution if all participants survive from such a relationship. For example, many internet service providers (hereafter ISPs) may benefit from the increase in average revenue per user as each user's data usage amount increases thanks to various content provided from content providers such as YouTube and Netflix. However, as the amount of content usage increases, the maintenance expenses also increase to provide a stable service to users; in other words, a host (i.e., content providers) may harm parasites (i.e., ISPs) [84].

4.3. Symbiosis in a Business Ecosystem

This section discusses the overall picture of symbiosis in the business ecosystem. We first discuss the relational characteristics of each symbiosis type and then highlight the dynamic nature of symbiosis in the business ecosystem. After that, we discuss the significant role of keystone species (i.e., platform providers) in the business ecosystem.

Firstly, mutualism is a relationship between participants who positively influence each other [78,85,86]. Under mutualism, each participant is eager to cooperate for value co-creation. Mutualism occurs not only in a relationship between participants but also in a business ecosystem when mutualistic relationships facilitate the co-evolution of participants in a business ecosystem [34]. In comparison with other types of symbiotic relationships, mutualism is the ideal type of relationship in a business ecosystem.

Secondly, commensalism is a one-way relationship between participants because the relationship does not guarantee mutual benefits [86,87]. This kind of relationship tends to be formulated in a business growth stage to incubate other participants in the ecosystem [34]. From a business platform perspective, a keystone species can leverage commensalism for its own advantage. In other words, a keystone species invests in its counterpart to expand its own platform business. By investing in promising participants in a business ecosystem, keystone species can identify and seize new opportunities for their own secondary business [15,34].

Thirdly, parasitism is an ironic relationship in a business ecosystem with negative influences [34,83,86]. In the case of parasitism, one participant negatively influences its counterpart, while its counterpart positively influences them. The one receiving a positive influence in the parasitic relationship evolves as a result of the parasitism; however, the negative influence of the symbiont not only harms its direct counterpart in the parasitic relationship but harms other participants in the business ecosystem [88,89]. Unlike other symbiotic relationships, parasitism sometimes triggers the co-evolution of keystone species and other participants as a defense mechanism in response to being harmed by a parasitic relationship.

Extant studies highlighted the dynamic nature of symbiosis in a business ecosystem. The symbiotic relationships in a business ecosystem are not static; they transition into different symbiosis types as the relationship between symbionts continuously changes [6,34]. For example, parasitic relationships can transition into other types of symbiotic relationships as a parasite (i.e., beneficiary symbiont) is being pulled out of its parasitic position [34]. In the case of commensalism, when the beneficiary symbiont matures, commensalism can transition into mutualism by co-evolving with keystone species [34].

In terms of the role of keystone species in the business ecosystem, as we can see in Figure 3, keystones are located in the center of symbiosis in a business ecosystem. Considering that a business ecosystem is based on relationships between independent networks constructed around a keystone species, as the leading actors in a business ecosystem, keystone species act as a business cornerstone, such as a platform provider in a business ecosystem [18]. In a business ecosystem, the size and the relationship between participants (i.e., symbionts) influence a business ecosystem's survival and death [90]. The network effect is essential for the success of a business ecosystem because it enhances competitiveness and increases the participants' basis of a business ecosystem. A business platform's network effects show that participants' relationships are core elements of a business ecosystem [77,91]. For this reason, keystone species need to make strategic decisions on symbiotic relationships with symbionts based on two points: whether the harm they received from the parasitic relationships threatens their core business and whether the cost of handling parasites is higher than the benefits of the resolution of such a relationship [18,31].

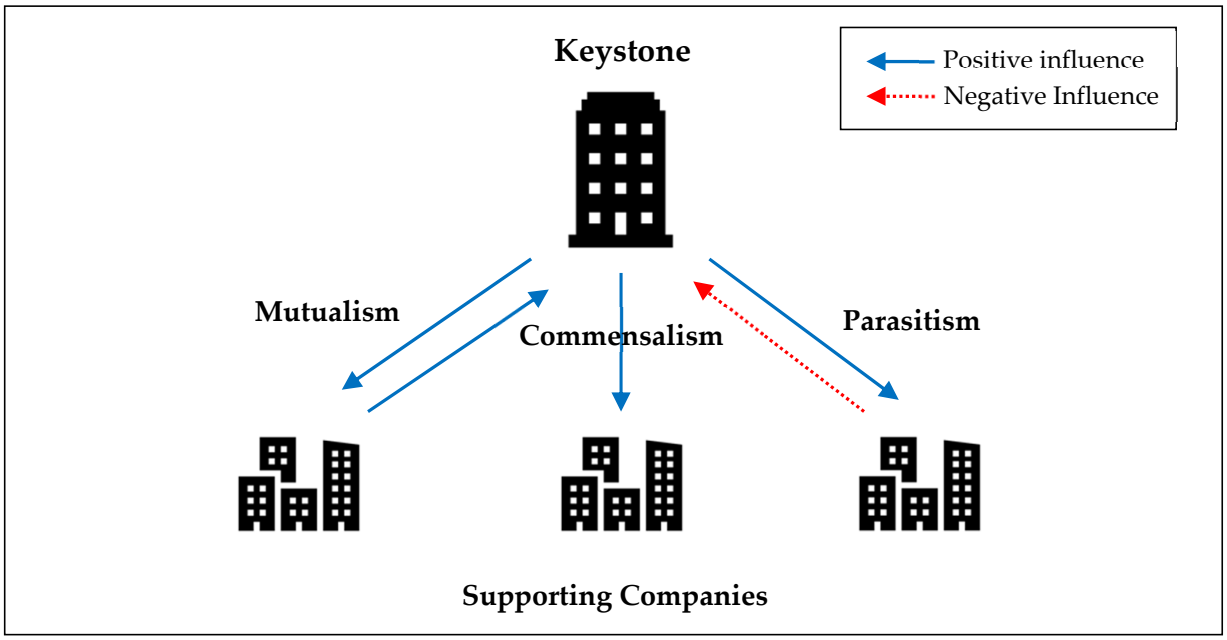

Figure 3. Symbiosis in a business ecosystem.

5. Conclusions

The findings showed unique motives and features of the three symbiotic relationships in the business ecosystem. Exploring symbiotic relationships in the business ecosystem allowed us to answer who, how, and why questions regarding the participants in a business ecosystem, for example, who participates in a business ecosystem, how participants are interrelated, and why they form symbiotic relationships. By answering these questions, we expanded the existing theoretical basis while establishing a theoretical foundation for further research. As Yao and Zhou highlighted the dynamic nature of a business ecosystem, symbiotic relationships are not static; they transition into different types as participants' relationships change over time. Therefore, it is essential to understand the dynamics between keystones and symbionts [34,42]. Because leveraging the dynamics of symbiotic relationships can help companies in various ways, such as access to other companies' resources and capabilities, strengthening business ecosystems, and utilizing network effects for their own interests. Mutualism is the ideal type of relationship because every participant is benefitting from the relationship. For this reason, other types of symbiosis, such as commensalism and parasitism, eventually lead to mutualism through the co-evolution of symbionts to pursue the mutual benefits from such a relationship [34,35]. Symbiotic relationships contribute to the business ecosystem by positively influencing every participant in the form of co-evolution since the health of symbiosis affects each symbiont's business performance [6,43,78,79].

By examining symbiotic relationships in business ecosystems, we contributed to the relevant research field with two points: introducing a new research agenda and the typology of symbiotic relationships in the business ecosystem. Firstly, we provided the big picture of symbiosis in the business ecosystem and brought attention to such an agenda based on findings from SLR. It is meaningful especially considering that extant studies regarding business ecosystems tended to focus on partial aspects, such as the roles and activities of keystone species; symbiotic relationships did not receive much attention from academics. Secondly, we suggested the typology of symbiotic relationships in the business ecosystem and described each type's relational characteristics and distinctive features based on extant discussions on symbiotic relationships.

This study provided managerial implications to platform providers regarding the strategic importance of leveraging symbiotic relationships in business ecosystems with two points: the spin-off from nurturing symbionts' capabilities and the facilitation of co-

evolution. Firstly, platform providers can enhance a platform's health while improving the overall outcome of a business ecosystem by cultivating a symbiont's capabilities and providing indirect assistance. As the border between competition and cooperation is becoming blurred, the relationship between a business platform and its participants has become the core competency for survival [92]. Due to the dynamic nature of symbiotic relationships, symbionts can contribute to the prosperity of a business ecosystem by attracting new participants as they evolve based on direct and indirect assistance received from platform providers. Secondly, platform providers can manage their relationships with symbionts for their own benefits by facilitating co-evolution [34]. As symbiotic relationships continuously change over time, a platform provider can strategically induce the transition of symbiotic relationships into other symbiosis types. For example, a platform provider can facilitate the transition of parasitism into mutualism or commensalism by assisting the evolution of parasitic participants. By doing so, platform providers can obtain positive influences from having relationships with other symbionts in the business ecosystem. The dynamic nature of symbiotic relationships implies that how platform providers operate makes a difference to the value of such relationships, and thereby the role of platform providers is critical for the success of business ecosystems [92].

Although we introduced the typology of symbiotic relationships in business ecosystems, this study has limitations mainly due to its research methodology. The limitations of this study can be summarized with two points: data limitation and lacking verification of the analysis results. In terms of data source, we conducted the SLR using a limited number of data sources such as ScienceDirect, Scopus, Web of Science, Springer, and snowball sampling. We tried to overcome this data limitation by adopting snowball sampling. However, this study did not consider additional data sources and gray literature. In terms of the research method, an SLR only provides a general view of a specific topic; therefore, it does not provide an in-depth analysis of a given topic. In terms of the research approach, we only examined symbiotic relationships in business ecosystems at a conceptual level, as our research is an exploratory study on symbiosis in business ecosystems.

Considering that research focusing on symbiosis in business ecosystems is still lacking, further research focusing on symbiosis in business ecosystems is much needed. This study only provided a primary theoretical foundation for further research based on SLR results. To develop the findings from this study, further developments for the theoretical foundation of symbiotic relationships in the business ecosystem are necessary. Further research based on an inductive theory building approach is recommended to build hypotheses and a theoretical framework. Furthermore, cases from heterogeneous industries need to be investigated to verify the findings from this study. For example, investigating the differences between established and emerging business ecosystems in terms of symbiosis types will broaden our understanding of symbiotic relationship dynamics and industry-specific features.

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