Guest editorial: Deconstructing business ecosystems: complementarity, capabilities, co-creation and co-evolution

1. Introduction

In the recent decade, there is a substantially increasing amount of studies on business ecosystems (Adner, 2017). The term "ecosystem" is borrowed from natural ecology (Moore, 1993) and now is not only widely adopted by high-tech and Internet firms (Benitez *et al.*, 2020; Leong *et al.*, 2016) but also by more established sectors from manufacturing to financial services (Rong *et al.*, 2020; Vink *et al.*, 2021). Scholars have made efforts to understand what ecosystems are, why they emerge and how they differ from other business organizations (Hou and Shi, 2021; Jacobides *et al.*, 2018; Kretschmer *et al.*, 2022; Moore, 2006).

It is advocated that business ecosystems should be recognized as the third organizational form which is different to markets and hierarchies (Moore, 2006). More specifically, business ecosystems have unique interorganizational relationships and arrangements compared to traditional markets (Williamson, 1979), vertically integrated supply chains (Cao and Zhang, 2011; Flynn *et al.*, 2010; Shou *et al.*, 2018) or geographically dispersed manufacturing networks (Shi and Gregory, 1998; Zhang and Gregory, 2011). Business ecosystems are more than just transactional relationships; they create the underlying infrastructure, human capital and other resources that are often shared or rotated across ecosystem actors. In short, it should be regarded as a new type of collective form for multiple, heterogeneous stakeholders (Cennamo and Santaló, 2019).

The fast development of business ecosystems is facilitated by emerging digital technologies, which help overcome difficulties in communication and transactions across organizational boundaries and geographic dispersion. A number of studies have touched upon the roles of such technologies in shaping the contexts of business ecosystems, including 3D printing (Rong *et al.*, 2020), big data (Hänninen *et al.*, 2018), blockchain (Saadatmand *et al.*, 2019), Industry 4.0 (Benitez *et al.*, 2020) and Internet-of-Things (Rong *et al.*, 2015). Nevertheless, further examination of many emerging technologies from a business ecosystem perspective, especially their respective roles in business ecosystems, is needed. Such emerging technologies include artificial intelligence (Wirtz *et al.*, 2022), autonomous vehicle (Alochet *et al.*, 2021), cloud computing (Shou *et al.*, 2020), digital twin (Parmar *et al.*, 2020) and smart home (Kim *et al.*, 2019), to name a few. Particularly, COVID-19 has significantly accelerated the implementation and adoption of digital technologies, thereby reshaping traditional industries and creating nascent business ecosystems.

Given the fast development of business ecosystems in practice, it is timely and meaningful to investigate the various aspects of business ecosystem to advance our knowledge on this progressive phenomenon. This special issue offers a number of studies that address interesting topics in a variety of ecosystems using different research methods.

2. Four aspects of ecosystems

With the surge of research on business ecosystems, there are a number of high quality reviews on this topic (e.g. Gomes *et al.*, 2018; Ranjan and Read, 2021; Vink *et al.*, 2021).

Industrial Management & Data Systems
Vol. 122 No. 9, 2022
pp. 1977-1986

0263-5577
DOI 10.1108/IMDS-09-2022-811

Therefore, we attempt not to provide a detailed review but to highlight a few issues that are of interests for future research. Inspired by the structure-conduct-performance (SCP) framework (Ralston *et al.*, 2015), we focus on three aspects of business ecosystem, i.e. *complementarity*, *capabilities* and *co-creation*. In addition, considering the salient dynamic nature of business ecosystems, we also emphasize *co-evolution* of ecosystems.

2.1 Complementarity

From the ecosystem-as-structure view (Adner, 2017), a business ecosystem can be regarded as an extension of a supply chain. In many well-known business ecosystems, there is a focal firm who provides a platform for a variety of actors, including supply chain partners. For example, Amazon and Alibaba provide e-commerce platforms for their suppliers and consumers (Leong *et al.*, 2016; Wang and Miller, 2020). Uber is another case by establishing a digital platform to share private cars with passengers (Benjaafar and Hu, 2020; Liu *et al.*, 2021). In such ecosystems, the interorganizational relationships are more complex than the dyadic buyer–supplier relationships in supply chains since in ecosystems there are more stakeholders who depend on one another to jointly create value (Adner and Kapoor, 2010; Chen *et al.*, 2022; Jacobides *et al.*, 2018). For instance, the success of Alibaba's e-commerce platform is dependent on numerous logistics service providers (LSPs), who are regarded as complementors to deliver the parcels from suppliers to consumers on time with a competitive price. PayPal and Alipay work as financial intermediary to facilitate cash flow among suppliers, service providers and consumers, which can be regarded as part of supply chain finance ecosystems.

The connections between the focal firm, supply chain partners and complementors determine the configuration of the ecosystem (Adner and Kapoor, 2010). The key difference between supply chains and business ecosystems is the most interesting and critical aspect to understand the mission and potentials of business ecosystems. It offers an important research area to explore business ecosystems beyond the functions and static relationships of supply chains. Besides investigating the nature of complementarity (Jacobides *et al.*, 2018), there are various topics related to complementors in a business ecosystem, such as complementor engagement (Saadatmand *et al.*, 2019; Wang and Miller, 2020), cooperating and competing with complementors (Hannah and Eisenhardt, 2018; Zhu and Liu, 2018) and selective promotion of complements (Rietveld *et al.*, 2019).

2.2 Capabilities

Individual business ecosystems may have similar configurations yet each actor in the ecosystem needs to develop their own capabilities to better utilize their resources and achieve strategic objectives. In the operations and supply chain management literature, many organizational capabilities have been studied, such as manufacturing (Patel and Jayaram, 2014), integration (Flynn *et al.*, 2010), innovation (Dong *et al.*, 2020) and learning (Gong *et al.*, 2018).

Given the distinctive contexts and configurations in a business ecosystem, it is expected that firms adopt different strategies and require unique capabilities to fully realize its potential in the business ecosystem (Cenamor and Frishammar, 2021). For example, firms need network capabilities to take advantages of interorganizational relationships for better access to and utilization of external resources (Kohtamäki *et al.*, 2013), which deserves more attention in business ecosystem research. In addition, besides the firm perspective to understand the new types of capability, it is also very critical to identify and deconstruct the strategic capabilities or functions of the ecosystem.

2.3 Co-creation

Co-creation has been a hot topic in the new century. Initially, it is on the engagement between firms and customers. Later, the concept of co-creation is broadened. From an actor-centric

view, it is a multi-party process that includes firms, customers and other institutions (Ranjan and Read, 2021). In a business ecosystem, value is created not only by focal firms and their supply chain partners but also by the complementors (Adner and Kapoor, 2010). The more complementors, the more value could be created for the end users and the higher probability for value co-creation by ecosystem members and consumers (Ceccagnoli *et al.*, 2012).

The outcome of co-creation could be either direct value such as products and services, or indirect value such as relationship and royalty (Ranjan and Read, 2021), which, to some extent, determines the performance of the business ecosystem. The research on co-creation also pays much attention to the sharing of the co-created value, which influences the trust among actors and hence business performance (Liu *et al.*, 2019). Moreover, it is important to note the long-term value of co-creation where a set of capabilities may be originally developed by ecosystem members for a specific purpose but over time they could be leveraged by other actors for similar or entirely different use, intentionally or serendipitously.

2.4 Co-evolution

A business ecosystem is a live meta-organization. It evolves constantly with the ever-changing environment. At the same time, each actor within a business ecosystem adapts to one another. It is recognized that competition and cooperation may coexist in inter-firm relationships (Hoffmann *et al.*, 2018; Liu *et al.*, 2014). Given the heterogeneity of interorganizational relationships in ecosystems, there are not only co-existing competition and cooperation between focal firms and suppliers but also complex relationships among supply chain members, facilitators, complementors, consumers and regulative agencies (Hannah and Eisenhardt, 2018). In such dynamic ecosystems, these actors and their relationships co-evolve over time to better create value for end users (Tiwana *et al.*, 2010; Wareham *et al.*, 2014). Hence, the co-evolution view of ecosystems helps better understand the complementarity and co-creation processes among multiple actors within the ecosystem (Hou and Shi, 2021).

3. Overview of special issue papers

This special issue of *Industrial Management and Data Systems* contains six papers. Each paper was double-blind reviewed by at least two peer expert reviewers and went through multiple rounds of revision. The six papers are summarized in Table 1.

The work of Cui *et al.* (2022) focuses on the dilemma of keystones in a business ecosystem. A keystone is the organizer of a business ecosystem. It plays a critical role in the business ecosystem, particularly in resource sharing and allocation within the ecosystem. Their study aims to explore how a keystone can govern its business ecosystem under the conditions of resource sufficiency and resource insufficiency. Conducting a single case study, they find that under the condition of resource sufficiency, keystones should make full use of resources to incubate more complementors, and further integrate the resources of the business ecosystem to create more value for their business ecosystems. Under the condition of resource insufficiency, keystones should break the boundaries of the business ecosystem and acquire external resources to meet the resource needs of complementors.

Fan *et al.* (2022) investigate a particular type of ecosystem, i.e. green innovation ecosystem. They perform a systematic literature review to summarize the current green innovation research, and then use content analysis to identify connectivity and crossovers between key concepts in the literature of green innovation and innovation ecosystem. By visualizing the similarity and difference between the two bodies of literature, they find that the two streams of research overlap on the roles of external actors but there is scant research investigating green innovation activities from the innovation ecosystem perspective. The authors propose

Table 1.
Summary of the special issue papers

Paper	Ecosystem	Research question	Perspective, framework, model	Research method	Key findings
Cui *et al.* (2022)	Business ecosystem	How do *keystones* govern their *business ecosystems* through resource orchestration under the conditions of resource sufficiency and resource insufficiency?	Resource orchestration perspective	Single case study	• A *keystone*'s resource-focused actions within its *business ecosystem* could be incubating and integrating as guided by a keystone strategy or acquiring and redeploying as guided by an adapting strategy • The required *capabilities* to govern a *business ecosystem* differ with resource condition. Efficiency (flexibility) *capability* is required for the condition of resource sufficiency (insufficiency)
Fan *et al.* (2022)	Green innovation ecosystem	Which topics in green innovation research can be discussed from the emergent *innovation ecosystem* perspective?	Innovation ecosystem perspective	Systematic literature review, content analysis	• Prior studies on green innovation mainly adopt a *foal firm* view while investigating actors from an *ecosystem* perspective may offer a new path for research • This study develops a framework of green *innovation ecosystem*, which includes direct and not-direct *value creators* and goes beyond the simply dyadic relationships, thus highlighting several promising research directions
Li *et al.* (2022a, b)	Digital innovation ecosystem	What are the appropriate *stakeholder* collaboration strategies to improve risk prevention performance in a digital *innovation ecosystem*?	TOE framework	Systematic literature review, network analysis, simulation	• This study validates the positive effect of *stakeholder collaboration* on risk prevention performance and reveals the importance of network reachability in formulating collaboration strategies • The strategy of strong–strong collaboration strategy can best enhance risk prevention performance in a digital *innovation ecosystem*

(*continued*)

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Paper	Ecosystem	Research question	Perspective, framework, model	Research method	Key findings
Liang *et al.* (2022)	Innovation ecosystem	How can a *focal firm* manage *complementors* in an *innovation ecosystem* to create competitive advantages?	Grounded theory	Multiple case study	• This study reveals four generic strategies to manage *complementors* • The *focal firm* engages functional *complementors* and collaborates with infrastructural *complementors* when the level of interdependence is high • The *focal firm* acquires functional *complementors* and nurtures infrastructural *complementors* when the level of interdependence is low
Zhang *et al.* (2022)	Innovation ecosystem	(1) Is the *ecosystem* organization superior to vertically integrated organizations in terms of innovation performance? (2) How do different structures of technological interdependency influence innovation performance?	NKC model	Computational experiment	• Integrated firms with centralized search demonstrate stable and consistent *performance* across different structures of technological interdependency • *Ecosystems* outperform integrated firms when the products exhibit modular or nearly-modular structures
Zhou *et al.* (2022)	Technology standard alliance ecosystem	How does the *focal firm* of a multinational technology standard alliance *ecosystem* engage different *actors* to participate in *co-creation* practice, achieve product collaborative innovation and reciprocal standard cooperation?	Extended resource-based view	Single case study	• *Value co-creation* dominated by the *focal firm* is embodied in the synergy of *actor engagement* and resource interaction, which mirror the mutual benefits and sustainable innovation of the alliance *ecosystem* • The standards co-development and achievement sharing deepen the process of *multi-actor engagement*

a green innovation ecosystem framework and offer recommendations for future research on green innovation.

The study of Li *et al.* (2022b) pays attention to the effect of stakeholder collaboration on risk prevention performance in a digital innovation ecosystem. They adopt the technology-organization-environment (TOE) framework to identify the risk factors of digital innovation reported in the current literature. The social network analysis method is applied to design stakeholder collaboration strategies from the ego and global network perspectives, and a simulation approach is conducted to evaluate the performance effects of the strategies on risk prevention. The authors reveal the importance of network reachability in formulating collaboration strategies and find that the strong–strong collaboration strategy works best in preventing risks in the digital innovation ecosystem.

The work by Liang *et al.* (2022) is also about innovation ecosystems. Their focus is on how a focal firm can manage various types of complementors. They conducted a multiple-case study of three leading focal firms with ecosystem strategies to understand innovation ecosystem governance. The case analysis results disclose four strategies to manage complementors. These strategies are contingent on the types of complementors and the level of interdependence. On the one hand, focal firms tend to engage functional complementors and collaborate with infrastructural complementors when the level of interdependence is high. On the other hand, focal firms tend to acquire functional complementors and nurture infrastructural complementors when the level of interdependence is low.

Another study on innovation ecosystem is from Zhang *et al.* (2022). They attempt to understand the performance difference between organizational structures (i.e. integrated firms versus innovation ecosystems) and the factors that lead firms to choose one over the other. Using the NKC model, they incorporate non-generic complementarities and modularity into the technological interdependence between different components. They examine four different types of technological interdependence (i.e. modular, hierarchical, nearly modular and random). Their computational experiment results show that integrated firms with centralized search demonstrate stable and consistent performance whereas an ecosystem significantly outperforms integrated firms when the products exhibit modular or nearly-modular structures.

Zhou *et al.* (2022) investigate a specific type of ecosystem. They conduct a single case study on a multinational technology standard alliance ecosystem, in which a focal firm from an emerging economy engages multiple actors in value co-creation practice. Adopting the extended resource-based view, the authors find that actor engagement sets the anchor for the focal firm to dominate resource interaction, achieving a greater interaction through goal co-discussion, standard co-construction and achievement co-sharing. Resource interaction is composed of resource identification, sharing and alignment, which prioritizes the practice of value co-creation.

4. Closing remarks

The six papers in this special issue cover multiple aspects of ecosystems, including complementarity, capabilities, co-creation and co-evolution (see Table 1). It is noted that four papers focus on innovation ecosystems, including one paper on green innovation system (Fan *et al.*, 2022) and another one on digital innovation system (Li *et al.*, 2022b). Indeed, both green innovation and digital innovation have attracted close attention in academia and practice in the recent years (Li *et al.*, 2022a; Vial, 2019). Also, innovation ecosystems have been a popular topic in the current literature. However, given the diversity of the business world, we call for more attention to other types of nascent business ecosystem, particularly those enabled by emerging digital technologies such as smart home (Kim *et al.*, 2019) or autonomous vehicle (Alochet *et al.*, 2021).

Just as the majority of extant literature on business ecosystems, most studies in this special issue scrutinize the firms in business ecosystems. However, other actors like not-for-profit organizations (NPOs), government agencies, universities and research institutes, are not sufficiently investigated in terms of their roles in the ecosystem and their links with other actors. As Fan *et al.* (2022) have noticed some important actors like influencers are largely neglected in the current ecosystem literature. In other words, this could be a promising research direction to investigate those overlooked actors in business ecosystems.

Business ecosystems are complex adaptive systems. This is why many authors adopt a case study approach (e.g. Cui *et al.*, 2022; Liang *et al.*, 2022; Zhou *et al.*, 2022) or a simulation method (e.g. Li *et al.*, 2022b; Zhang *et al.*, 2022). A longitudinal case study provides rich information of a business ecosystem while a multiple case study enables comparison between case firms to offer deep insights. A computational simulation helps speculate the possible outcomes of interactions among actors. Nevertheless, given the increasing availability of various types of data, we call for empirical studies on business ecosystem using primary or secondary data. For example, in a typical mobile game ecosystem, there are interactions between players, reviewers, game developers and the platform, which offer rich data for empirical study. However, we also admit that it will be a huge challenge to analyze the interrelationships among multiple actors.

As a cross-disciplinary area, business ecosystems have attracted scholars from various fields. It is a fertile and promising research area to achieve theoretical contributions and we also hope that practitioners would find the academic articles such as those in this special issue insightful for their practice.

Last but not least, we are truly grateful to all the reviewers and the Co-Editor-in-Chief, Professor Hing Kai Chan, for their kind support, without which this special issue would have been impossible.

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