

Value Co-Creation in Digital Innovation Ecosystems

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The innovation ecosystem guides the transition from individual value creation to multi-actor value co-creation by coordinating the interests of multiple parties for cross-border cooperation and enhancing the efficiency of technological innovation and resource integration in the system.

digital innovation ecosystem

value co-creation

differential game

1. Introduction

With the incremental innovation and breakthrough of the new generation of information technology, intelligence, networking, and digitalization are developing deeply. The digital economy has become a new driving force for economic development, disrupting how enterprises obtain sustainable competitive advantage ^[1]. The innovation ecosystem guides the transition from individual value creation to multi-actor value co-creation by coordinating the interests of multiple parties for cross-border cooperation and enhancing the efficiency of technological innovation and resource integration in the system ^[2]. The innovation ecosystem value co-creation is based on the value galaxy and value network theory and emphasizes the discontinuous, interactive, and non-linear characteristics of the value co-creation process. Focusing on inter-actor collaboration, resource sharing, and symbiotic evolution, it has become a new paradigm for studying complex innovation phenomena ^[3]. With the rapid development of digital technology, the operation and development of innovation ecosystems have also incorporated digital elements, not only emphasizing the use of digital resources, digital technologies, and digital technology facilities as critical elements of innovation but also reshaping the value co-creation logic of innovation subjects ^[4]. Building a digital innovation ecosystem is a crucial channel to breaking industry, regional, and enterprise boundaries and realizing digital value co-creation. Nowadays, more and more enterprises make digital innovation ecosystems to achieve interactive delivery of value ^[5], further promoting the breakthrough of digital technology innovation barriers and boundary extension. Haier, Facebook, Google, Amazon, and many other digital natives have formed open digital innovation ecosystems to gain competitive advantages continuously. Digital innovation ecosystems are loosely interconnected networks formed by firms and other innovation agents. All participating agents collaborate to participate in value co-creation through shared technologies, knowledge, and skills. Still, significant differences exist in the roles these innovation agents assume and play ^{[6][7]}.

Although the business and academic circles have reached a consensus on the digital innovation ecosystem's core role and development prospects ^[8], the research is still in development. The current research results must provide more mature guidance for enterprises' digital innovation practice. The study results on the dynamic optimization

and coordination strategy of value co-creation of the digital innovation ecosystem are rare. Existing research mainly focuses on the value co-creation mechanism of the digital innovation ecosystem. Still, to a certain extent, there is path dependence, which makes it challenging to cross disciplinary barriers in this field and needs to be more conducive to the comprehensive deepening of the problem and theoretical formation of practice. There is an urgent need to adopt a decision-making approach to comprehensively and systematically grasp the nature of value co-creation decisions in the digital innovation ecosystem.

2. Enterprise Digital Innovation

2.1. Evolution Analysis of Enterprise Digitalization Research

The keyword time zone view reveals the evolutionary trends and development trends in the field ^[9], and the time zone view of digital innovation in enterprises is shown in **Figure 1**. Combined with the keyword evolution, the research hot spots in the field of enterprise digital innovation are divided into three stages. Phase I (2003–2010): theory construction and development period. Scholars have conducted in-depth research on digital technology and thus laid the foundation for developing enterprise digital technology. At this stage, research hot spots have been reflected in information systems, data diffusion, and collaborative innovation. Phase II (2010–2016): digital technology application period. Technology development and data technology advancement have driven the R&D capability of enterprise digital technology. The hot spots of research in the period are reflected in digital technology, business models, digital products, and technology governance. Phase III (2017–2022): digital technology transformation period. Superimposed on the Industry 4.0 context, enterprises face urgent digital technology transformation challenges. The hot spots of research in this period are reflected in digital platforms, innovation ecosystems, value co-creation of innovation subjects, and digital services.



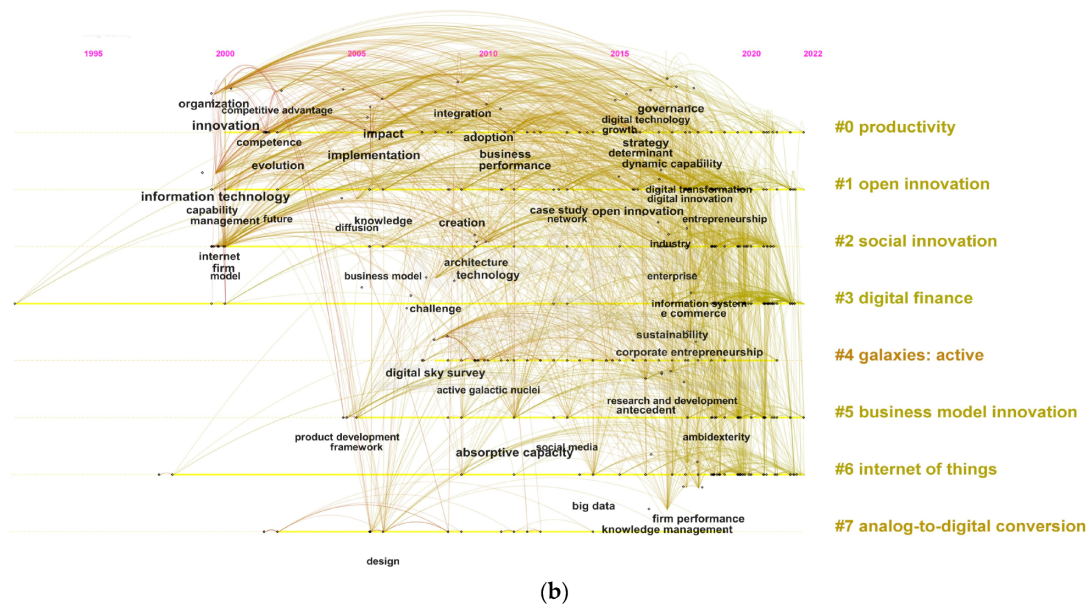


Figure 1. Keyword Time Zone View for Enterprise Digital Innovation. (a) Keyword co-occurrence network. (b) Evolution path knowledge map.

2.2. Current Status of Research on Enterprise Digitalization

In the era of the digital economy, digital innovation has become an essential engine for enterprises to cultivate new dynamic energy. Facebook, Google, Amazon, etc., have been making breakthroughs in product, process, and business model innovation under digital technology, facilitating the acquisition and continuation of competitive advantages. Yoo and Henfridsson et al. first defined the concept of digital innovation ^[10]. They proposed that digital innovation is implementing new combinations of digital and non-digital resources to produce new products. Fichman and Santos et al. further suggested that the digital innovation process is divided into four stages: discovery, development, diffusion, and impact ^[11]. Porter and Heppelmann integrated digital technologies and traditional physical products and proposed that digital innovations have convergent properties ^[12]. Compared with the conventional innovation management theory logic, the digital innovation process is characterized by a looser innovation process, difficulty in determining the innovation subject in advance, and blurred boundaries between the innovation process and the innovation result. Digital innovation can face more severe challenges as digital technologies are embedded in traditional products and services, capable of generating new products and services that fundamentally change the nature of products and services ^{[13][14]}. To access and integrate different resources, enterprises rely on the unique environment of innovation incentives provided by digital technology platforms, which may harm competition and innovation ^{[15][16]}. Technologies such as intelligent Internet, cloud computing, and big data in the digital context are changing the industry's structure and competitive nature while impacting organizational change, performance, and digital entrepreneurship. Digital platforms and ecosystems are places where enterprises create and capture value, facilitating new ways for participating actors to build knowledge and relationships and providing new ways for global customers to develop and deliver value ^[17].

3. Digital Innovation Ecosystem

The innovation ecosystem concept originates from the ecology field, an organic combination of ecology, system science, and innovation theory. After Tansley introduced the concept of “ecosystem” in 1935 [18], scholars have enriched and extended the idea of an innovation ecosystem. Moore first introduced the concept of corporate ecosystems in 1993 by the analogy of biological systems to corporate competition [19]. Adner subsequently pointed out that innovation ecosystems are open systems that link the individual and the whole [20]. Since then, the innovation ecosystem has undergone an iterative spiral from “sustainable development” to “open innovation” and from “value creation” to “value co-creation”.

The digital innovation ecosystem is a complex network system of several subjects and organizations relying on digital technology for products and services, featuring digitalized innovation elements, virtualized participating issues, and ecological inter-subject relationships [21]. The circular flow of data elements promotes the heterogeneity of innovation subjects in the digital innovation ecosystem, the complexity of resource integration and sharing process, and the challenge of technological innovation research and development [22]. Because of these significant differences, the cross-domain flow of innovation resources and value distribution becomes possible, so the value co-creation of the digital innovation ecosystem has a more significant trend of iteration and upgrading [23]. Different innovation subjects and environments in the ecosystem rely on digital technology to realize the combination of digital and non-digital resources, stimulate continuous endogenous innovation within the system, and make digital innovation more stable and sustainable [24][25]. On the one hand, it reflects the inherent characteristics of the innovation ecosystem; on the other hand, it highlights the emerging technologies in the digital innovation environment [26]. Scholars have revealed the internal logic and importance of multiple innovation subjects participating in value co-creation in the digital innovation ecosystem from different perspectives. Suseno and Laurell et al. proposed that a digital innovation ecosystem is an organization that uses digital technology to create new products and values and has a strong interactive relationship with stakeholders [27]. Senyo and Liu et al. believed that the digital innovation ecosystem reflects the impact of digital transformation on the innovation ecosystem. Digital technology is not only the object of innovation but also the promoter of innovation activities [28]. Beliaeva and Ferasso et al. conducted an exploratory case study of an IT company in Brazil [29]. They concluded that there are significant differences in the participants and relationships supporting the innovation ecosystem during the evolution of enterprise digital capability from low to vigorous. Based on the background of Industry 4.0, Benitez, Ayala, and Frank concluded that the innovation ecosystem promotes the resource integration of SMEs. Moreover, with the support of the Internet of Things digital technology, innovation ecosystem members collaborate to realize value creation [30].

4. Multi-Subject Value Co-Creation

4.1. The Evolution of Multi-agent Value Co-Creation Research

The keyword time zone view of value co-creation in industry is shown in **Figure 2**. Combined with the evolution of keywords, the research on value co-creation shows a trend of “binary relationship—simple system—complex system network relationship”. The research results of value co-creation of the innovation ecosystem are increasingly

abundant. Meanwhile, the current research results can be divided into stages: the subject and initiation method of value co-creation, co-creation channels, and co-creation forms and processes.

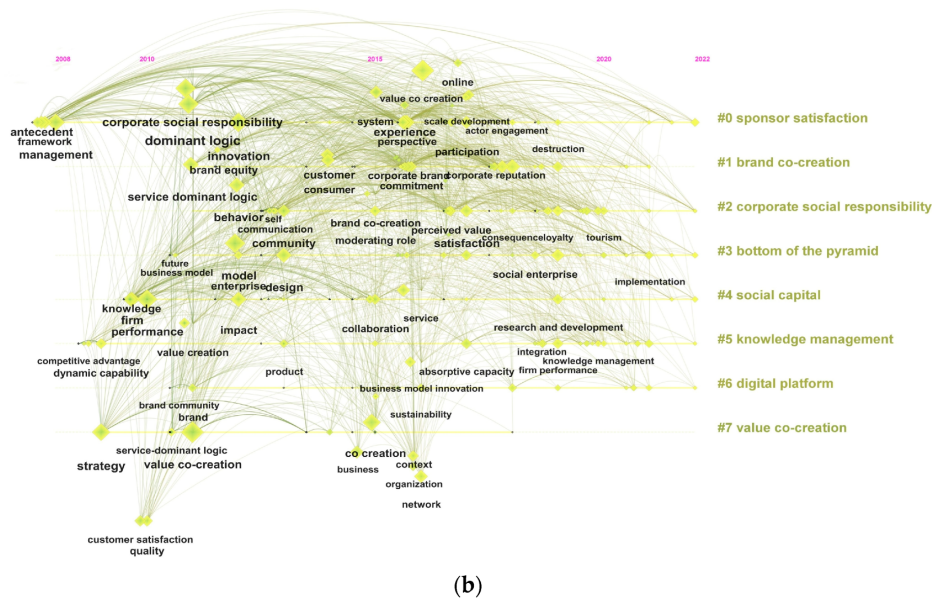
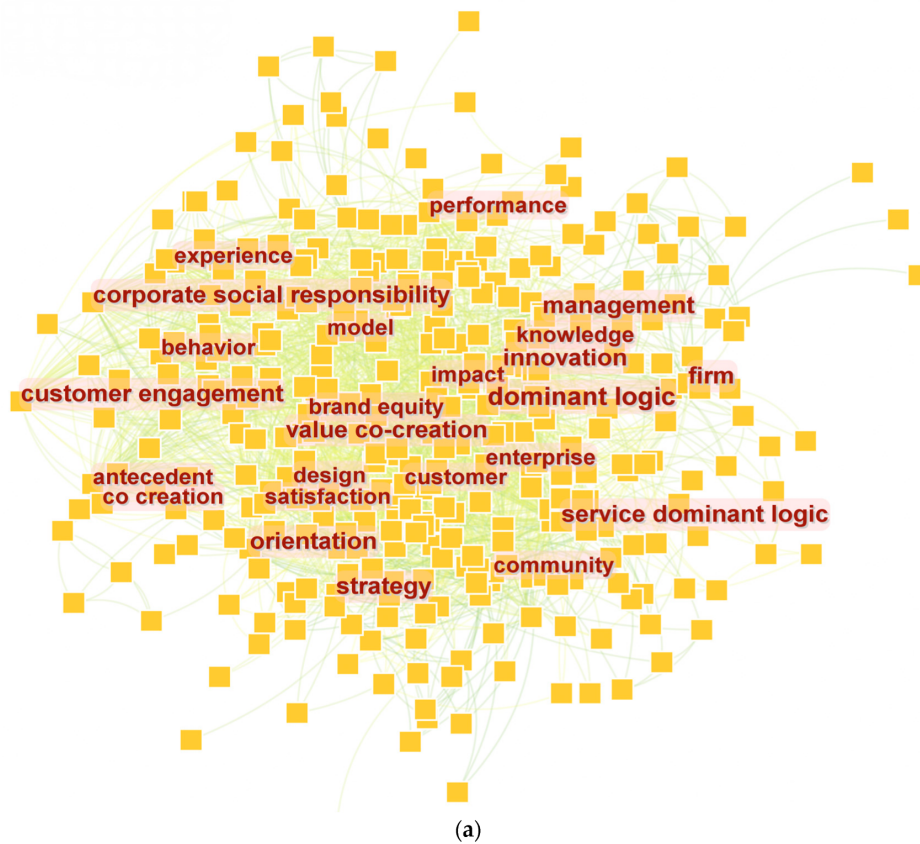


Figure 2. Keyword time zone view for enterprise value co-creation. (a) Keyword co-occurrence network. (b) Evolution path knowledge map.

4.2. Current Status of Existing Research on Value Co-Creation

In the 19th century, the germ of the idea of value co-creation arose in the field of marketing management [3]. In the 1960s, scholars gradually described value co-creation behavior based on the customer production theory. Customers are believed to participate in product production or service use based on their own needs, which promotes the enterprise's technology research and development innovation and rational allocation of resources to realize sustainable value creation. Ramirez first introduced the concept of value co-creation [31], which has been widely discussed in academia. The current concept of value co-creation can be divided into three levels: One is the relational interaction level. Tóth and Peters et al. argued that value co-creation is a process in which multiple actors participate and create value in an interactive approach and suggested that strengthening the relational governance of innovation agents is conducive to achieving value co-creation [32]. The second is the environmental support level. Payne and Dahl et al. believed that the value creation of a service ecosystem in the digital environment is based on the interaction between people [33]. There are differences in the mechanisms of value co-creation behaviors among different types of participants, so the innovation ecosystem leaders need to adopt different governance approaches. The third is the value guidance level. Holbrook earlier defined and delineated customer value in value co-creation, arguing that value co-creation is mainly divided into economic, hedonic, and social values, including intrinsic and extrinsic values and self-directed and other-directed values [34]. Ye and Kankanhalli found that enterprises increased value co-creation opportunities and improved digital technology service performance using service-led logic for system design and IT services [35].

With the evolution of the research on the co-creation of enterprise value, the duality relationship between enterprise and customer develops into a multi-stakeholder relationship. It extends to the collaborative participation of multiple subjects in the innovation ecosystem. The behavioral ecology of value co-creation has evolved from the traditional offline interaction to the online dynamics of the online environment and then to a digital innovation ecosystem that combines online and offline. As new resources for value creation, the latest digital technologies have created a strong link between the interaction methods and interaction environment of value co-creation and technological development by overturning the traditional rules of linking resources in industrial organizations [36]. Aluri and McIntyre et al. found that effective and purposeful value co-creation between customers and firms stimulates new knowledge integration and positively influences future innovation outcomes [37]. Chi and Bi et al. argued that the more frequent and closer the customer–firm interaction is, the more it helps to improve the efficiency of new product development [38] for the application of the research model of enterprise value co-creation. Demirezen and Shetty developed a differential game model to study value co-creation between customers and suppliers, arguing that the level of effort of both parties is dynamic in supply chain and information technology environments [39]. Broeke and Paparoidamis used mathematical methods to conclude that enterprises would derive more excellent value from collaborating with customers than from independent innovation [40]. Ketonen-Oksi and Valkokari constructed a participant structure model to study the factors influencing value co-creation in innovation ecosystems. Still, they ignored the dynamic nature of value co-creation and the lagging nature of outcomes [41].

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