

Review

Sustainable Development of Platform Enterprises: A Synthesis Framework

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Abstract: Enterprises are the most important core organizations of the country and modern society, and their growth has always been a focal point in the theoretical field. This paper aims to focus on the sustainable development of platform enterprises by exploring the mechanism of platform growth. Thus, this paper reviews the literature and analyzes the challenges faced by platform enterprises during the four stages of birth, expansion, leadership, and self-renewal, as well as the strategies they have adopted. The main aims of this paper are to help understand the growth process of platform enterprises and identify three key points that need to be addressed for sustainable growth, including the disadvantages of resource externalities, the importance of the restructuring of business models, and the urgency of fulfilling social responsibility. To address the exogenous nature of resources, platform enterprises should pay attention to the initiative of complementors, the distribution of benefits, and ecological orchestration. The impact of technology, especially artificial intelligence, on business models and the application of technology to restructure business models should be given attention. It is also necessary to pay attention to how platform enterprises undertake their social responsibilities. A synthesis framework with seven propositions for future research has been proposed.

Keywords: platform enterprise; growth of enterprises; lifecycle; strategy management; sustainable development



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1. Introduction

The rapid development of information technology in the 21st century has greatly reduced the dependence of platforms on physical infrastructure and fixed assets. Building and expanding platforms have become simpler and cheaper. In the era of the digital economy, economic and social activities are constantly embracing digitalization, and many platform enterprises have emerged, enabling producers and consumers to engage in high-value communication through platforms, enhancing the ability to capture, analyze, and exchange large amounts of data, and continuously creating value [1]. In the 21st century, the platform economy is prevalent. Both GAFA (Google, Apple, Facebook, and Amazon) in the United States and BAT (Baidu, Alibaba, Tencent) in China have performed strongly and become platform leaders in their respective markets. At the same time, traditional enterprises such as Kodak, which once held a large market share, find it difficult to maintain competitive advantages.

The platform ecosystem is composed of three main entities: platform enterprises (platform builders), complementors (suppliers providing complementary products or services), and users (demanders of platform products or services) [1,2]. Platform enterprises are at the core of the platform ecosystem network and play a cornerstone role in the entire business ecosystem [3,4], also known as platform leaders [5,6]. From the definition of platform

enterprises in the literature, platform enterprises need to possess three major characteristics: (1) Providing a platform architecture that satisfies the participation of multiple groups and determines the way complementors interact with the platform [7]. (2) Promoting interaction and generating network effects. The more applications complementors provide, the higher the demand generated. At the same time, a larger consumer scale will attract more complementors. (3) Encouraging innovation among complementors. The platform relies on complementors to provide products and services, and the quality of the products and services provided by complementors is directly related to the platform's competitive advantage, so the platform needs to encourage complementors to innovate and provide them with the appropriate resources.

How do platform enterprises surpass traditional enterprises? Numerous studies have proven that platform enterprises with these characteristics differ from traditional ones and leverage resources to create new value continuously [1]. Unlike the Resource-Based View (RBV), which considers technology, human resources, land, and capital as the core resources for business growth [8], user installations are considered the most valuable resource for platforms [9]. The user installation base, originally referring to the number of users installing a certain software [10,11], now refers to the number of users on the platform. The get big fast (GBF) strategy, which focuses on "acquiring users quickly, can lock in users and undermine the ability of rival platforms to do the same [11,12]. The network effect generated from users' interaction is also considered an important strategic resource for platform enterprises [13]. The indirect network effect generated between complementors and users on the other side of the platform enhances the core value of the platform [9]. Most studies emphasize the fact that there is interdependence and mutual influence among different participants [14] and focus on how platform owners can attract many end users and complementors to enhance indirect network effects [15,16]. The expansion of the user installation base of the platform can provide complementors with a larger user pool and more opportunities to achieve competitive advantages by leveraging network effects [10]. Platform enterprises compete on a different basis than traditional companies.

In addition, platform enterprises can leverage their existing user resources to bypass Schumpeter's innovation and enter neighboring markets, which is known as the envelope strategy [9]. The platform evolves through envelope strategy [17]. By the envelope strategy, a platform enterprise can build an ecosystem with itself as the core through a series of processes such as cross-border, integration, and restructuring, so that the industrial boundary in the Internet context is increasingly blurred. Especially for platform enterprises such as Amazon, Alibaba, or Tencent, implementing the envelope strategy is common in their cross-border behaviors. How boundaries change is an important topic for platform enterprises' growth and advantage acquisition. The theory of new institutional economics holds that the critical point for a company to establish boundaries is when the cost of internal production for a transaction equals the market cost or the cost of external enterprise production [18]. But the boundary of a platform moving outward or inward may not only be due to considerations of economic efficiency but may also be due to threats from competitors' platforms or the perception that complementors may transform into competitors [19]. To increase the conversion cost of complementors or their dependence on the platform, the platform will also erect new boundaries to enhance the differentiation from other platforms [20]. The degree of openness of the platform's boundaries and when to absorb complementors' innovation are also related to the acquisition of advantages for platform enterprises [21]. It can also be seen that the growth mechanism of platform enterprises is also different from that of traditional enterprises.

Since breaking through the traditional theoretical constraints, the platform enterprise development research results are abundant and a very challenging research field. These research findings have formed many new perspectives and explanations, greatly helping us understand how platform enterprises can grow and gain competitive advantages. At the same time, we also found that platform enterprises should face several new challenges in their growth, which provides new space for future research.

Firstly, from an internal perspective of the platform ecosystem, as the scale of the platform expands, the relationship between platform enterprises and complementors becomes increasingly complex and difficult to manage [22]. Complementors are important participants in the platform ecosystem for providing complementary products or services to the platform [16]. The quality of products provided by complementors affects the competitiveness of the platform [23–25]. But as the number of complementors increases, there may be some complementors who do not act on the platform, leading to free-riding behavior and reducing their innovation contribution to the platform [26]. How to maintain the relationship with complementors and continuously stimulate their creative enthusiasm has been a challenge that platforms have always faced, and it is also a problem worth further exploration.

Secondly, from the external perspective of the platform ecosystem, technological changes and business model innovations can potentially disrupt incumbent enterprises in the platform market at any time. Even though a platform business is almost always in a “winner-take-all” situation, this does not mean that it can always achieve this goal once and for all. It is common for an incumbent company in the platform market to be caught up and surpassed by latecomers. Symbian system was once a leader in the smartphone industry, supported by numerous smartphone manufacturers such as Nokia and Samsung. However, due to the complexity of the underlying code in the Symbian system, high-level technical expertise was required for development and maintenance. The Android and IOS systems attracted more developers due to their relatively low development difficulty. So, there are more applications of software or games emerging on the Android and IOS platforms to meet the diverse needs of smartphone users. In just five years, from 2007 to 2012, they accounted for 85% of the global smartphone market shipments, while Symbian fell to 5%, leading to the decline of Nokia’s entire smartphone empire.

Thirdly, although the platform business model brings great convenience to people’s lives and work, with the intensification of competition and the expansion of scale among platform enterprises, it has exposed some problems that are not harmonious with social development. The rapid development of taxi e-hailing platforms, represented by Didi Chuxing, has overturned the whole rental industry, not only solving social employment problems but also realizing the supply–demand balance. However, challenges, such as nowhere to claim responsibility after traffic accidents in the service process, are sometimes against the traditional labor relations and social security systems [27]. The environmental pollution problems caused by using a large amount of disposable tableware or tape on online food delivery and e-commerce platforms have attracted the attention of experts and the public. For example, in recent years, China’s annual express delivery volume has exceeded 60 billion pieces. Based on an average tape usage of 0.8 m per package, the amount of tape used each year is 48 billion meters, which can circle the equator of the Earth nearly 1200 times. The main material of the tape is polyvinyl chloride, which takes nearly a century to degrade. Therefore the growth of the platform is not only a matter of the company itself, but also affects the sustainable development of society as a whole.

In summary, the sustainable development of platform enterprises exhibits complex and dynamic system engineering. How can platform enterprises maintain their competitive advantage and continue to develop? There is already a wealth of research focused on platform enterprises, which explains how platform enterprises gain competitive advantages for growth and lays a theoretical foundation for us to continue exploring this issue. This study aims to discover research hotspots for sustainable growth by exploring the growth mechanisms of platform companies. Therefore, we must review the relevant literature on the growth of platform enterprises and understand what achievements have been gained and what should be done further to identify the gaps in current research. This has important practical and theoretical significance for maintaining the growth of platform enterprises.

2. Research Methodology

Since we need to clarify the growth mechanism of platform enterprises and identify the gaps in current research, the integrative review methodology, which intends to address mature topics or new emerging topics, might better help us to analyze the extant literature [28,29]. Firstly, this paper selects Web of Science, Scopus, China Knowledge Network (CNKI), and other databases, and uses keywords such as “platform”, “platform enterprise”, “bilateral market”, “platform ecosystem”, and “platform strategy” to search the relevant literature. Second, the source type is limited to papers, reviews, and conference papers, and the subject category is limited to “business, management, and economics” with a timeframe from 1 January 2000 to 1 January 2024. For English papers, we choose journals listed in JCR. For Chinese papers, we select journals listed in CSSCI. To ensure the quality of the selected papers, the impact factor of all the journals selected is above 2.0. Third, we quickly skimmed the titles and abstracts of the papers to determine whether the main content of the papers was relevant to the growth of platform companies and our research objectives [30]. Finally, a total of 139 papers in English and 52 papers in Chinese were collected in this study. The literature search process is shown in Figure 1.

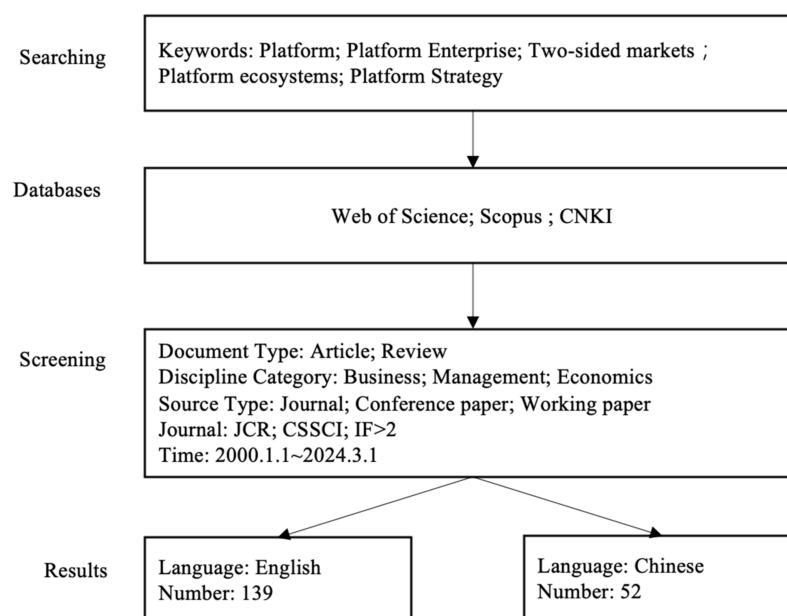


Figure 1. Process of searching literature.

Secondly, to analyze the literature better, Teece’s (2017) four-stage lifecycle theory on platform growth was considered in our research. The four stages of the platform lifecycle are birth, expansion, leadership, and self-renewal [31]. The birth stage refers to the stage where a platform enterprise proposes a value proposition that needs to be perceived by the market. In the expansion stage, the platform enterprise gradually expands its scale, expels competitors, and consolidates its competitive advantage. At this point, the platform needs to focus on a strategic balance on whether the boundary is moving and the degree of platform openness. The leadership stage of a platform refers to maintaining transactions between users and complementors within the platform, as well as maintaining control over the platform ecosystem. In the self-renewal stage, it is necessary for the platform enterprise to bring new ideas or technology to the entire ecosystem. Based on the definition of each stage of platform growth, we planned to determine which stage of the platform the papers we collected discussed according to their content. Then, by carefully reading these papers, we aimed to clarify the challenges and difficulties faced by platform enterprises in each stage and pinpoint which strategy platform enterprises adopted to cope with these challenges from the perspective of strategy management, and how they used advantages to achieve growth. For example, the paper “Institutional Work as Logics Shift: The Case of

Intel's Transformation to Platform Leader" focused on the measures taken by Intel when transitioning from traditional supply chain logic to a new platform logic [32]. Intel needed to make its new value proposition understood both internally and externally to obtain the recognition of platform leadership. So, this paper was evaluated to discuss mainly the content of the platform's birth stage.

3. Challenges and Strategies of Platform Enterprises at Different Growth Stages

3.1. The Birth Stage

3.1.1. Platform Challenges

The competition between platform enterprises is no longer based on the assets they own, but on their respective user installation base, unlike traditional competition [33]. The user installation base maps the value of the platforms. Users are undoubtedly valuable resources for platforms. With positive feedback from network effects, platforms that accumulate a larger user base will provide greater value [9,34]. A platform with more users means higher market value, which affects the complementors' choice of platform [10].

However, when a platform enters the market, it is difficult to expand the user base for encountering a series of difficulties. The low acceptance of new things by users brings cognitive pressure to the platform. Users often have high expectations for established platforms [16]; therefore, they are unable to break through inertia barriers when facing the entry of new platforms [10]. If users do not enter the platform for a long time, the platform will encounter the "penguin problem" [35]. Meanwhile, for users, what attracts them most is the products or services provided by complementors on the platform, not the platform itself. And what attracts complementors is also not the platform itself, but the large number of users on the platform. Complementors only view platforms with many end users as valuable, and only platforms with many users can bring them significant economies of scale [10]. Therefore, in the birth stage, due to the lack of a certain scale of complementors and users, each side would be unwilling to join the platform due to the absence of the other side, and the platform would encounter the "chicken and egg problem" [36].

The lack of organizational legitimacy is also a dilemma that new companies entering the platform market may encounter. As mentioned earlier, platform models are completely different from traditional business ones [33]; therefore, there may be a temporary lack of organizational legitimacy for enterprises entering the platform market. The new institutional theory suggests that all actors will face legitimacy constraints. The formation of new fields is mainly reflected in the acquisition of organizational legitimacy. For example, when Intel changed its traditional supply chain logic dominated by computer assemblers to a new platform logic, its position in the value chain shifted from being a supplier for computer manufacturers to being the creator of industry standards (PC architecture and open interface standards). This not only triggered a change in the roles of other participants in the value chain but also led to a fundamental shift in institutional logic [32]. Breaking through the constraints of existing systems and obtaining legitimacy is crucial for the survival and growth of platform enterprises [34].

3.1.2. Platform Strategy

As mentioned earlier, in the initial stage of platform establishment, issues of obtaining user resources need to be addressed first. Due to the phenomenon of "winner-take-all", some scholars believe that platform enterprises should adopt a GBF strategy in the early stage of growth to quickly acquire and lock in user resources, and stabilize the market share from the perspective of strategy management, as mentioned in Section 1 [12,37]. Rapid traffic diversion is an effective method to solve these problems [38], which means quickly importing user traffic for new platforms through some channels. The incomplete price competition model in game theory demonstrates how price strategies work for the "chicken and egg" problem [36,39]. How to subsidize platform participants is also crucial for the success of the platform growth [14]. Price strategies are suitable for attracting one side to quickly enter the platform by subsidizing another side, thus solving the "penguin" and

“chicken and egg” problems [38]. Besides price strategies, some other non-price strategies are also effective [21]. For example, a unilateral strategy is to create a business that only benefits one single user group, and then transform that business into a platform to attract another type of user who wants to interact with the first type of user. A group of important users can be invited to join the platform through certain benefits to attract another group of users to join the platform [21]. Obtaining user traffic with the support of the parent company is also a shortcut [40]. Of course, one-sided emphasis on the scale of users will lay hidden dangers for platform development [41]. To achieve sustainable development, it is necessary to attach importance to improving user quality [11].

For some platform enterprises, obtaining organizational legitimacy is crucial for their development. Only with legitimacy can a platform continuously obtain other resources and support [41], thereby achieving growth and success [42]. Research on the legitimacy acquisition of platform enterprises is mainly based on the theoretical framework of institutional logic. For example, in the case study of Intel, it was not only necessary to legitimize externally, to shape Intel into a strong and compassionate leader image in the new industry logic, but also to gain identity recognition internally. When the industry recognized and adopted Intel’s technical standards, and employees were aligned with the company’s goals, Intel’s organizational legitimacy as a platform leader was successful [32]. As Intel grew, technological resources became the key to maintaining its platform leadership position [43]. Xiaomi gained legitimacy through “arranging for mutual understanding”, “subverting design”, “increasing credibility”, “emotional mobilization”, and “rights guarantee” [44]. Similarly, Alibaba continuously strived to build legitimacy, overcame weaknesses in intellectual property, and promoted platform development. Alibaba achieved social legitimacy through the mechanism of innovation by the poor and innovation for the poor [45]. The research on Didi Chuxing indicated that strategic decisions need to combine the logic of efficiency with the logic of legitimacy. When developing a business under high institutional pressure, efficiency needs to be sacrificed to obtain legitimacy [46].

There is also a small amount of literature on the acquisition of other key resources by platform enterprises, which focuses on all the growth stages of the platform. For example, in the case study of Feiyou Technology, a Chinese enterprise for commercial aviation data services, the evolution process of the platform enterprise was analyzed based on the management of open data resources [47]. The growth mechanism in the birth stage is shown in Figure 2.

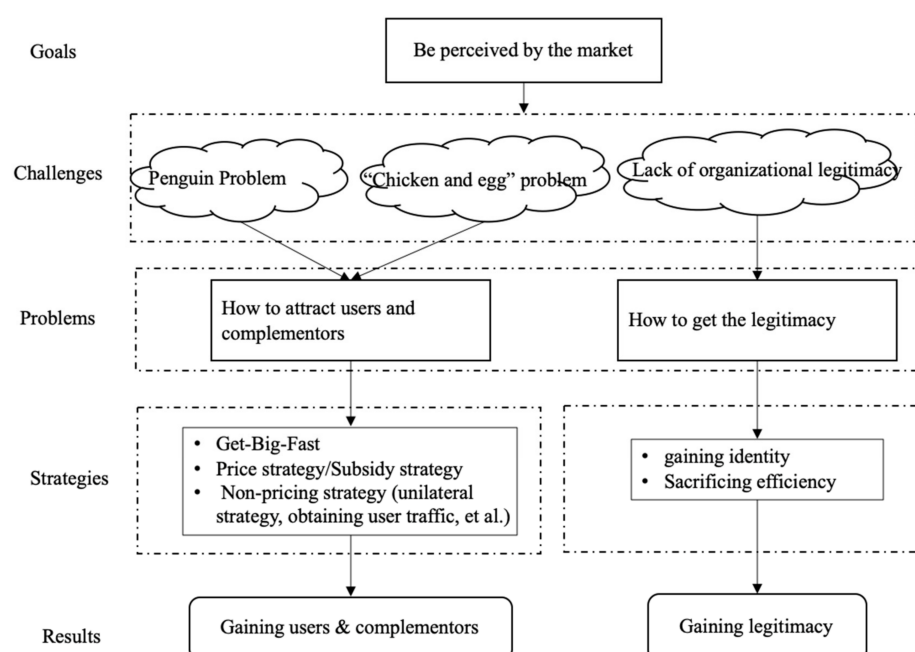


Figure 2. Growth mechanism in the birth stage.

3.2. The Expansion Stage

3.2.1. Platform Challenges

The focus of platform growth during the expansion stage is on managing boundaries, including mobility, openness, and other changes. The movement of platform boundaries refers to changes at the market boundary level. Boundary openness refers to the relaxation or restrictions on the utilization of platform resources [48,49]. The platform moves its boundaries outward, usually for two reasons. First, due to the high economic scope or user overlap between the products of the platform and that of the target platform, the platform moves its boundaries outward for economic efficiency purposes [10,19]; the second reason is to expand boundaries in the face of threats from competitors or complementors for the purpose of maintaining or enhancing market power [19]. However, the platform cannot expand endlessly. The platform needs to establish a reputation that will not erode the complementors' markets [50]. The excessive grabbing of economic benefits will lead to contradictions [51], undermine the enthusiasm of complementors to enter the platform, and even squeeze them out of the platform.

The degree of openness and when to absorb complementors' innovation are important parts of ecosystem strategy [52]. When a platform needs to harness external innovation as a supplement to internal innovation, the platform will open its boundaries to achieve a unique competitive advantage [53]. Much restrictions on platform access can easily push complementors towards competitive platforms. The openness of platform boundaries promotes innovation among external complementors, but excessive openness also poses risks to platform development [50]. Therefore, in the expansion stage, the platform enterprises need to achieve a strategic balance on boundary movement and openness to obtain maximum benefits.

3.2.2. Platform Strategy

In the expansion stage, the factors, such as market power, capability, and legitimacy, as well as economic efficiency, will be weighed together to decide whether the boundaries should be changed [19]. Therefore, the existing research on platform boundary management is mostly conducted from the perspective of strategic or organizational management.

When platform enterprises decide whether to move platform boundaries for considerations of economic scope or user overlap with the target market [54], the development of the platform is economically efficiency-driven and like traditional enterprises. The strategy of boundary movement for this kind of purpose is also known as the envelope strategy [9]. If the user base overlap between the platform and target market is high and symmetrical, the envelope strategy will have a relatively high success rate. Taking WMP as an example, WMP offered no major functional improvements over RealNetworks (Real)'s software, whose share accounted for 90% of the multimedia player market in 1998, yet the user base heavily overlapped [10]. Users and content providers found that the Microsoft Windows operating system bundled with WMP became more attractive. As a result, Microsoft squeezed out Real successfully and the Windows Platform moved its boundary to the multimedia player market. Envelope strategies are further divided into horizontal and vertical ones. The horizontal envelope strategies mainly consider whether there is a significant overlap in the user base between the platform and the target market which is even irrelevant, while vertical envelope strategies are conducted because there is a high economic scope with a target market that is an adjacent link in the value chain [10]. However, in practical cases, the implementation of envelope strategies aimed at boundary movement is more complex. Although both Apple and Samsung used envelope strategies to seize the market, their focuses were different. As a pioneer in the market, Apple often took the lead in entering the blue ocean market. Although its envelope strategy overlapped with its competitors' customers, it provided products with innovative features. Unlike Apple, Samsung, as a market follower, adopted a weak substitution strategy for product functions [55]. By the study of the growth process of Facebook and LinkedIn, it was found that the movement of the platform boundaries strengthened their market power and prevented competitors from

snatching market share. Of course, platforms cannot simply move boundaries outward. When they perceive the lack of legitimacy, they will stop moving [19]. Three key actions for building competitive advantage in the platform envelope strategy are identified: building a basic database that covers user characteristics, stimulating network effects, and building a business ecosystem, covering various communities [34].

The degree of openness of a platform is related to the control of boundary resources. The technology interface of the platform determines the way the platform enterprise interacts with external complementors [19]. Boundary resources are formed in the interactions [56]. The platform provides an integrated architecture of hardware and software standards as the foundation for developing complementary products [57]. The boundary resources of the platform not only include Software Development Kits (SDKs), Application Programming Interfaces (APIs), and corresponding rules but also include protocols, intellectual property rights, etc. [58,59].

Open boundaries can authorize application developers to enter the platform or relinquish direct control of the platform [48]. Increasing the openness degree of the platform can improve the accessibility of platform resources and encourage complementors to participate in platform activities [60]. Platform openness can occur at multiple dimensions, leading to various strategies for managing openness [31]. Horizontal strategies for platform openness include licensing, joint standard setting, and technological interoperability with competing platforms, while vertical strategies include backward compatibility, exclusive protocols, and absorption of complementary products [11,61]. When the platform perceives that a complementor may transform into a competitor [19] or discovers that the complementor is not acting [61], it will close the boundary openness for that participant. It follows that opening or closing borders controls the activities of external participants on the platform. Platform enterprises sometimes erect new boundaries to enhance differentiation with other platforms. By distinguishing itself from other platforms, platform enterprises can increase the conversion cost for complementors, enhance their dependence on their platforms, and thus strengthen the platforms' power boundaries [20]. Erecting boundaries can also increase the entry threshold for complementors, thereby improving the quality of complementary products and surpassing other platforms [60].

The growth mechanism in the expansion stage is shown in Figure 3.

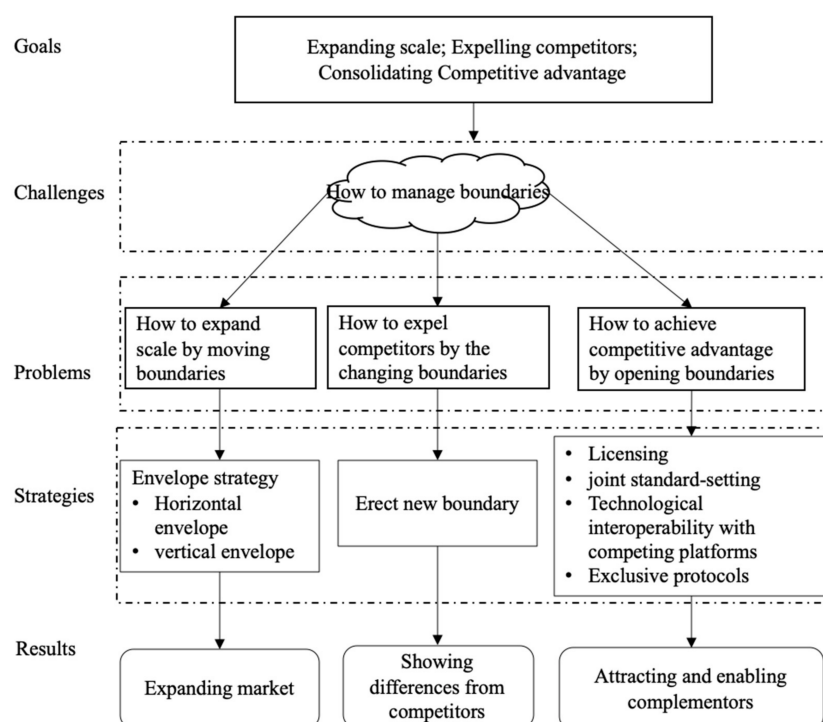


Figure 3. Growth mechanism in the expansion stage.

3.3. The Leadership Stage

3.3.1. Platform Challenges

In the leadership stage, it is necessary to maintain transactions between users and complementors within the platform, and maintain control over the platform ecosystem [31]. The difficulty in coordinating between platform owners and complementors is a challenge for the platform's sustainable development [22]. The insufficient participation of complementors can become a major factor in restricting the platform's development, and the quality of the platform partially depends on the quality of the products provided by complementors [24,25]. Studies have shown that it may not be sufficient for a platform alone to motivate external participants to make real contributions. Complementors will only increase their contributions when a structured but collectively determined governance process is created [62]. The management of platform access plays an important role in shaping complementors' activities of value creation [10]. Empowering complementors means enabling them to create new value for the platform. Especially for latecomer platforms in the market, their competitive advantages in complementary products can compensate for their disadvantages in competition with incumbent enterprises [24].

For complementors, who prefer to engage in development on multiple platforms, it reduces development risk [10]. For example, application developers tend to develop on both Android and iOS platforms simultaneously. The phenomenon of complementors participating simultaneously in multiple platform ecosystems is called multihoming [63]. Because of multihoming, complementary products appear on multiple platforms, making it difficult for platforms to leverage the uniqueness of their products to surpass their competitors [11]. This is the main reason why the software industry has always relied on exclusive contracts and intentional incompatibility to force developers to use only one development tool.

3.3.2. Platform Strategy

To maintain the leadership position of the platform, it is necessary to select and connect suitable complementors [64]. The management of complementors mainly involves three methods. One is how to motivate complementors to provide excellent products or services. The characteristics of the boundary resources determine the technological and social environment for the interaction between platform enterprises and complementors, leading to differences in the attributes of interaction activities, which in turn affects the type and degree of dependency between them [64]. When a platform grows, it is necessary not only to determine to whom to open boundary resources [1] but also to increase the degree of openness and introduce more complementors for the sake of platform expansion [48,65]. The access restrictions of the platform may also lead to complementors' turning to competitive platforms [66]. To encourage complementors to provide better products or services to users, the platform transfers design capabilities to them by allocating resources [26] and stimulates competition among complementors. At the same time, the platform also needs to screen complementary imitators and limit competition congestion [2]. Platforms should also avoid entering complementors' markets to encourage complementors to participate actively in platform activities [60]. Since platform owners and complementors will face more complex issues of profit allocation [19], the platform should pay more attention to ensure the interests of all the participants [67]. The case of Taobao, a subsidiary of Alibaba in China, shows that the platform can use algorithms to combat the opportunistic behavior of complementors, protect the interests of high-quality complementors, and improve the quality of platform complementary products.

The second is how to increase the dependence of complementors on the platform, which is usually explained from the perspective of resource dependence in the existing literature. The platform enterprise controls key resources such as the core components and standard interfaces of the platform, and the possibility of complementors accessing potential user markets [68]. Platform enterprises can collaborate with complementors for product development and commercialization, with each responsible for one aspect.

Compared to individual development, complementors can achieve better performance and therefore rely more on the platform [69]. The interdependence of the entities on the platform would drive the evolution of the platform, resulting in updates to platform strategies [70]. The case study of the Li & Fung company found that this company continuously proposed systematic value propositions and other measures to increase the non-linear dependence of other member enterprises on it, thereby promoting itself to move to the core position of the network and gain platform leadership [6].

The third is how to achieve control over complementors. Conventional means, such as hierarchical control, cannot be applied in a platform context, because complementors are often not under the platform owner's direct control [71]. Therefore, this will lead to the phenomenon of multihoming, which indicates that the conversion cost between different platforms is very low (costs include fixed costs for learning, searching, accepting alternative platforms, variable transaction costs, regular membership fees, etc.). Whether complementors choose multihoming mainly depends on the comparison of costs and benefits. A platform can reduce the phenomenon of multihoming through pricing strategies or establishing strong cross-border network effects with users [72]. In addition, platforms can also enhance the uniqueness of products by signing exclusive agreements with complementors [11,38]. However, signing exclusive agreements is not an easy task. Complementors who can provide high-quality products are more inclined to establish relationships with multiple platforms because multihoming can be a tool for preserving bargaining power [73]. Moreover, implementing exclusive agreements in practice requires more caution as it is susceptible to policy sanctions. In April 2021, the Chinese State Administration for Market Regulation imposed a fine of 18.281 billion yuan on Alibaba for forcing complementors on the platform to “choose between two”. In October of the same year, Meituan was also fined 3.442 billion yuan for “abusing its market dominance in the online food delivery service market in China”.

The growth mechanism in the leadership stage is shown in Figure 4.

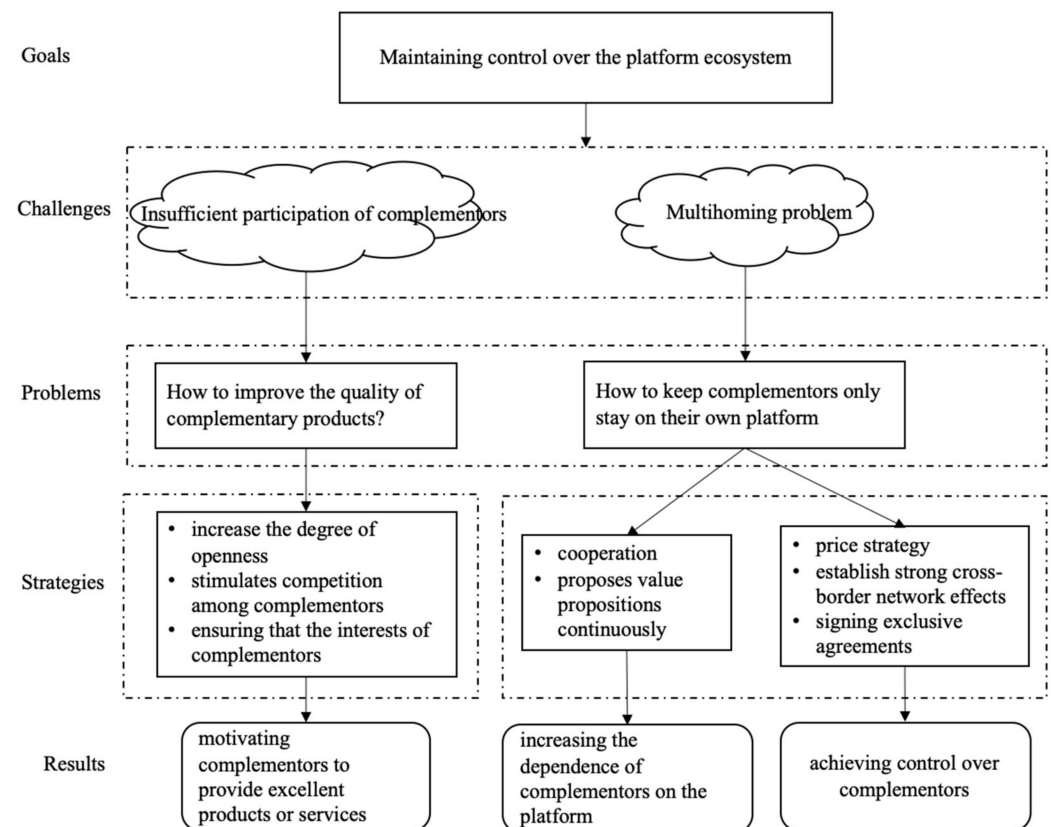


Figure 4. Growth mechanism in the leadership stage.

3.4. The Self-Renewal Stage

3.4.1. Platform Challenges

The fourth stage of the platform, the self-renewal stage, means that the platform enters a new stage of determining new value propositions for reform. This stage specifically refers to the sustainable development stage of super platforms. Super platforms, such as Google, Apple, and Alibaba, already have a large user base and many sub-platforms. The “winner-take-all” position of the platform is only a state of time, since, when the business environment changes and disruptive technologies emerge, the platform may lose its share and even be quickly eliminated [38]. Therefore, what the platform needs at this stage is to make fundamental updates [31]. For example, Taobao beat out eBay China, which had received investment from eBay, to rank No. 1 in China’s online shopping market and became the leader in 2006. Since then, Taobao has been exploring the upgrading of e-commerce platforms. In 2010, with the rise of social networks in China, Taobao sought to combine e-commerce and social networks, launching Juhuasuan, a group-buying product. Then with the arrival of 4G and 5G network technology, Taobao began to transition to mobile Internet applications, in time to seize the traffic entrance in the mobile Internet era. In 2015, Mobile Taobao became the benchmark of the Internet era, with the average daily DAU (Daily Active Users) exceeding 110 million people.

Even if platform enterprises have become market leaders and occupy a “winner-take-all” position, they still need to be sensitive to the impact and threats that environmental changes may bring to them. They should be prepared to change at any time, capture market opportunities, and develop forward-looking strategies [51].

3.4.2. Platform Strategy

There are various forms of self-renewal for platforms. This means that the self-renewal strategies for each platform are unlikely to be the same and difficult to replicate. Companies across industries such as banking, insurance, and enterprise software will transform their existing product platform ecosystems into innovative platform ecosystems to increase their generativity [74]. Clusters may reinforce the resilience of the ecosystem, so new business opportunities can be explored through clusters without jeopardizing the whole ecosystem [75].

Compared to the literature on the former three stages, there is less literature on what platform enterprises should do in their self-renewal stage, as only super platforms have evolved into this stage. However, several related case studies have provided some ideas for how the super platforms should upgrade themselves. TikTok utilized a series of internationalization strategies to leverage short video technology into overseas markets and achieve ecological innovation. TikTok covered 150 countries and regions in 2022, with over 1 billion DAU worldwide [76]. The Chinese digital platform giants, such as Baidu, Alibaba, and Tencent, used the Platform Business Group (PBG) strategy to develop powerful synergies by leveraging the technology and linking tightly together several different platforms to offer multiple services [77]. The evolution and upgrading experience of Haier’s digital platform showed that enterprises should continuously provide support for creating ecological value and more importantly, empower employees efficiently through network organizations and enable them to continuously contribute to the platform [78].

The growth mechanism in the self-renewal stage is shown in Figure 5.

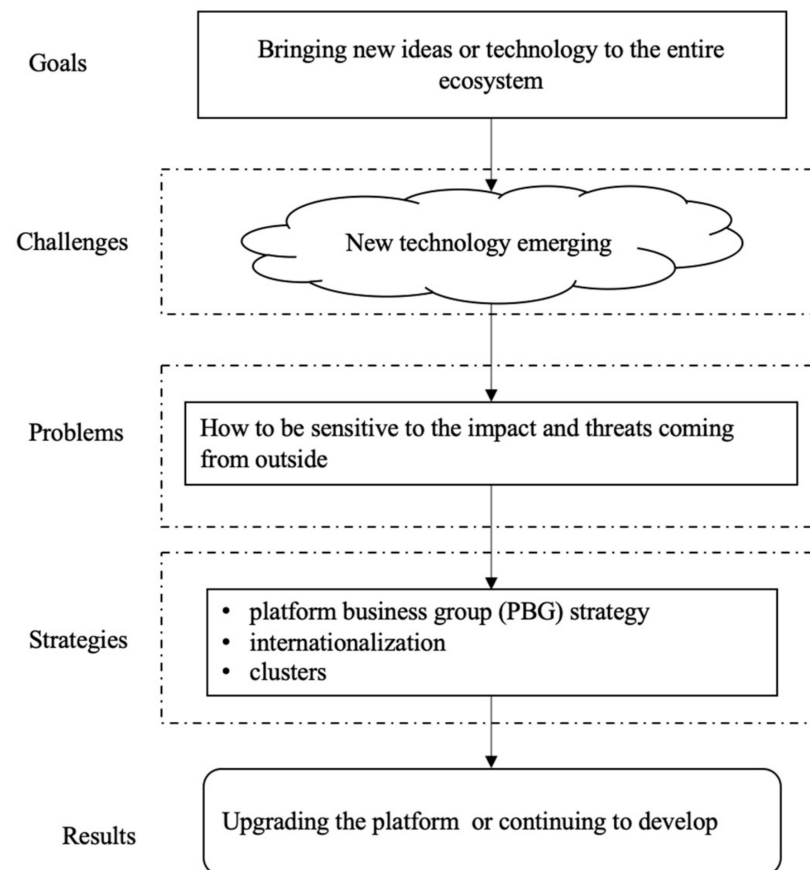


Figure 5. Growth mechanism in the self-renewal stage.

4. Sustainable Growth of Platform Enterprises

The platform economy has been developing for more than 20 years from its inception. During this period, scholars have conducted extensive research on the growth of platform enterprises. Using the integrated review methodology, we analyzed the challenges the platform enterprises encounter and the response strategies they take, respectively, in the four stages defined by Teece [31]. As shown in Figures 2–5, in the early stages of development, platform enterprises often attract users to join the platform through price strategies mainly, and then expand market share, focusing on managing platform boundaries. As the platforms gradually expand, the platform enterprises begin to focus on managing complementors and need to be vigilant about the impact of new technologies and new business models. The breadth and depth of strategy management in platform enterprises have been greatly expanded. Today, there are many mature platform enterprises in almost every market, and even many platform enterprises occupy a “winner-take-all” position. According to the platform lifecycle proposed by Teece [31], most platform enterprises are currently in the third (leadership) or the fourth (self-renewal) stage. The growth issues faced by the platform enterprises are no longer how to enter the market or attract bilateral users. The focus of research on platform enterprises has shifted to how to maintain the leadership position and sustainable growth. Through the literature review of the growth mechanisms of platform enterprises in four stages, we have identified three key points for the sustainable development of platform enterprises.

4.1. How to Resolve the Disadvantage of Resource Externalities

From the birth stage, when they are dedicated to gaining users, to the expansion stage, when they try to manage boundaries, and then to the leadership stage, when they strengthen the management of complementors, platform enterprises have essentially been solving the problem of resource externalities. Under the RBV, the key for traditional

enterprises to maintain their competitiveness lies in monopolizing high-quality resources. However, the key resources required for the growth of platform enterprises, including users, complementors, and the products or services they provide, are not owned by the platform in terms of property rights. The exogenous nature of resources leads to a different growth mechanism for platform enterprises compared to traditional enterprises.

Since platforms control key resources such as core components and standard interfaces of the platform [68], platform enterprises determine the entry and exit of complementors by managing platform boundary resources [48], and determine the allocation of resources within the complementors. Complementors often achieve survival through the passive selection of response strategies [79]. The complementary interaction with a platform is often considered to be like dancing with elephants, and the activities of complementors on the platform have always been accompanied by threats from platform enterprises [47]. Current research often focuses on how to formulate governance principles for platforms from their perspective, considering how platforms can incentivize and control complementors better based on factors such as economic benefits and power scope. However, in recent years, scholars have begun to pay attention to the subjective initiative of complementors. The multilateral relationships faced by complementors and the issue of relationship management from a micro perspective are explored [80]. The key to complementary participation in platform activities is to reduce dependence while enhancing complementarity [81]. A case study conducted on the design enterprise, Rococo Group, which collaborated with the DingTalk platform, showed that complementors could adopt a “dependent upgrading” strategy to promote their digital transformation by using the platform resources [82]. This case also showed us that the purpose of complementors in platform activities was no longer just to acquire users, but to achieve the goal of enterprise transformation and upgrading. The passive position of complementors is gradually shifting towards active. When the expectations of complementors for the platform change, the relationship between complementors and the platform will also change accordingly. With the development of platform enterprises, the competition in the complementary product market is becoming increasingly fierce, which has led to an increase in the complexity of platform enterprises in solving resource externalities [83].

Resolving the issue of exogenous platform resources through the relationship management between platform enterprises and complementors remains a key concern for the sustainable growth of the platform, and relates to the first future challenge mentioned earlier. Therefore, based on the existing literature, the relationship between platform enterprises and complementors can be improved from three perspectives, as follows:

Firstly, attention should be paid to the initiative of complementors. The demands of complementors have changed from obtaining user pools on the platform [84] to achieving the goal of transforming and upgrading their enterprises. Complementors may not passively cater to the platform as they did in the past, but try to reduce their dependence on the platform and break free from its control by taking certain measures. Therefore, simple strategies such as signing exclusive agreements are no longer sufficient to maintain and stimulate the enthusiasm for innovation of complementors. The platform enterprises need to adjust the relationship with them by empowering complementors more to achieve a win-win situation.

Secondly, attention should also be paid to the distribution of benefits. The complementors are in a disadvantaged position because of a lack of bargaining power [85]. If the distribution of benefits between platform enterprises and complementors is not handled properly, the enthusiasm for innovation of complementors is easily undermined [86]. As the initiative of complementors strengthens, their bargaining power will gradually increase. How to design distribution mechanisms should be guided by collective interests on the platform. Both reward and punishment methods and distribution rules are included to encourage the innovative behavior of complementors and avoid opportunistic behavior [87].

Thirdly, a watchful eye should be kept on the recently emerging academic term “ecological orchestration”. The ecological orchestration strategy emphasizes that the platform leader manages interaction and collaboration among different participants and achieves value co-creation through a series of purposeful and thoughtful actions, which means the platform leader needs to orchestrate the entire platform ecosystem, not just resources. Some scholars have begun to pay attention to the application of ecological orchestration. For example, Xiaomi’s ecological orchestration strategy was established through a cooperation system based on value co-creation, promoting innovation among complementors, and continuously upgrading the platform ecosystem [83]. The case study of Haier can also provide us with some inspiration. Haier built a digital twin platform network that could provide enterprises with a comprehensive view of the products, manufacture, supply chain, customer experience, and profitability. Through the digital twin platform network, Haier integrated the information of different links into a virtual entity, opened the whole process, and effectively involved all the stakeholders into the business activities of the enterprise to improve the social benefits [88].

Due to limited research on how to maintain the relationship with complementors from these three perspectives currently, there is still a lot of research space in the future. Based on the above, we propose three propositions for future research as follows.

Q1: How can platform enterprises empower complementors and encourage them to innovate from a win–win perspective?

Q2: How can reward and punishment and distribution mechanisms be designed and optimized based on the principle of encouraging complementors?

Q3: What is the difference between ecological orchestration and resource orchestration, and how can platform enterprises mobilize the enthusiasm of complementors through ecological orchestration?

4.2. How to Restructure a Sustainable Business Model

The internal and external environment of enterprises is constantly changing, and no business model can remain unchanged to adapt to this ever-changing environment. To maintain leadership in the platform ecosystem, it is necessary to build a sustainable business model for the platform, which is the foundation for promoting knowledge or information exchange among different participants [89].

The driving force of technology on platform growth cannot be ignored, because the development of platform business models is based on the rapid advancement of network and computer technologies. The technology interface adopted by the platform determines the way the platform enterprise interacts with complementors [19]. Based on data-driven tools, a community feedback loop has been created, which makes the platform models superior to traditional ones [21]. Technology is undoubtedly an important factor affecting business models. As mentioned earlier, Taobao’s shift from PC mode to mobile mode is in line with the development of 5G networks. Taobao, as the leader of the online shopping market in China, has consistently maintained a market share of over 80%. However, the market share of Taobao has dropped below 60% due to the erosion of TikTok in recent years. The competition between Taobao and TikTok can be said to be the competition of recommendation algorithms. While Taobao adopts the algorithm called “Thousand People and Thousand Faces”, which accurately promotes traffic based on the user consumption ability, purchasing habits, and so on, the algorithm of TikTok is based on the interest and behavior habits of users to push streams accurately. So TikTok puts forward the value proposition of “interest e-commerce” to distinguish it from the traditional e-commerce model of Taobao.

Especially in recent years, the development and gradual maturity of AI (artificial intelligence) technology have aroused widespread interest among scholars [90,91]. AI refers to intelligent machines that can simulate human cognition, and the application of AI technology has recently become more commonplace among digital platform services [77]. The adoption of AI can lead to significant improvements in productivity and efficiency

in our lives [92], such as the facial recognition algorithms used in Alipay and Apple Pay, or algorithms used to recommend news and websites in Headline. AI can act as a catalyst in reorganizing platform business models and industry architectures. AI-driven applications can be the next artifact innovation, which will modify users' behavior, either by providing users with new alternatives or connecting them with new resources, platforms, and values [77]. The emergence and popularization of AI may reshape the form of the value chain and value creation in the future, change the interaction between platforms and complementors, and lead to the emergence of new industry standards and architectures, as well as the emergence of new business models. Therefore, the development of AI may provide some thought-provoking questions for future research. For example, how platform companies should be alert to new technologies and business models is also a topic worth exploring.

Based on this, the following propositions are proposed in this paper.

Q4: How can a platform's business model be restructured to gain momentum for sustainable development?

Q5: How are business models affected by the development of information technology? How will AI affect platform business models? How will AI promote value creation?

4.3. How to Fulfil Social Responsibility

The platform economy shapes our work and life [93] and has become increasingly important [16]. But it also causes many negative impacts, such as traffic safety issues brought about by taxi e-hailing platforms [27], youth protection issues caused by new media platforms [94], or pollution problems brought about by E-commerce platforms. It is an urgent requirement that platform enterprises undertake their social responsibilities, which will influence consumer extra-role behaviors besides bringing reputation advantages to the enterprises [95]. However, after reviewing the literature on the four stages of the growth of platform enterprises, we found that there is little academic discussion on how to address this issue.

Platform enterprises often do not proactively undertake their social responsibilities because all enterprises are profit-oriented. Super platforms often have dual roles as both "athletes" and "referees", so they can achieve the self-empowerment of their data. With these data advantages, platform enterprises can achieve the vertical expansion of market dominance. For example, Taobao, which places the link to its self-operating Tmall supermarket on the homepage of its app, introducing the buyers to the Tmall supermarket. Therefore, platform enterprises may go against their value proposition in pursuing benefits. It is only under the pressures of public opinion or policy that platform enterprises take measures to stop pursuing economic benefits. There is a gap in the current research on the lack of social responsibility among platform enterprises.

Based on this, the following propositions are proposed in this paper.

Q6: From the perspective of platform enterprises, how can the contradiction between economic benefits and fulfilling social responsibilities be balanced? How can social responsibility be fulfilled better by reforming business models and adopting new technologies?

Q7: From the perspective of the government, how can the motivation of enterprises to fulfill their social responsibility be stimulated and how can they be supervised to fulfill their responsibilities?

A synthesis framework for future research is shown in Figure 6.

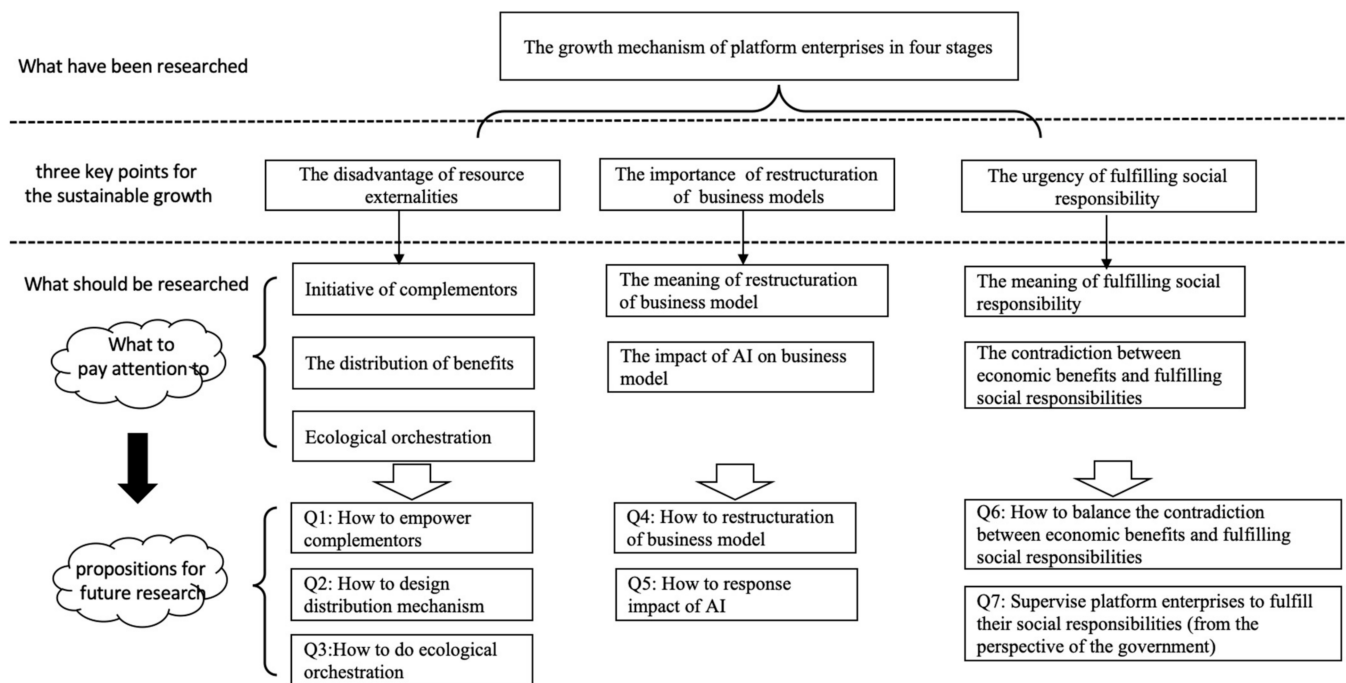


Figure 6. A synthesis framework for future research.

5. Conclusions

The platform business model based on the Internet has changed economic patterns. How can platform enterprises overtake traditional enterprises? Previous researchers have conducted a lot of research on the growth of platform enterprises. Enterprises are the most important core organizations of the country and modern society, and their growth and sustainability have always been focal points in the theoretical field. This paper adopts the integrative review methodology, combined with the lifecycle of platform enterprises proposed by Teece [31], sorts out the growth bottlenecks encountered by platform enterprises, and clarifies the strategic decisions to achieve growth in each lifecycle stage. The literature review above proved that the strategies adopted by platform enterprises are becoming increasingly complex as the internal and external environment changes. In the birth stage, the platform enterprise focused on how to acquire and manage resources mainly by price strategies to attract two-sided users. The platform's strategies focus on how boundaries can be moved or crossed in the expansion stage. The key to platform growth lies in maintaining good relationships with complementors in the leadership stage to achieve competitive advantages. The strategic focus then shifts to the application and development trends of new technologies and new business models for sustainable growth in the self-renewal stage. Through a review of the literature on the growth mechanisms of platform enterprises in four stages, we have found that the sustainable development of platform enterprises requires addressing three key points, which are the disadvantages of resource externalities, the importance of the restructuring of business models, and the urgency of fulfilling social responsibilities. To address the exogenous nature of resources, the platform enterprises should pay attention to the initiative of complementors, the distribution of benefits, and ecological orchestration. The impact of technology, especially artificial intelligence, on business models, and the application of technology to restructure business models should be given attention. It is also necessary to pay attention to how platform enterprises undertake social responsibility. To address these points, a synthesis framework (Figure 6) with seven propositions for future research has been proposed.

5.1. Contributions

This paper has two main contributions. Firstly, this paper categorizes and analyzes the literature in the field of platform research based on Teece's platform lifecycle, to gain a clearer understanding of the growth characteristics of each stage and the coupling between the challenges faced by the platform enterprises and the strategies adopted in each stage. For platform enterprises, it is necessary to clarify the stage of platform development they are in and their growth goals at this stage. They should consider the comprehensive impact of internal and external factors such as the platform type, lifecycle stages, and competition environment, then decide what kind of strategy to take. So, our research results can provide useful suggestions for the strategic choices of platform enterprises.

Secondly, through the literature review above, we have identified three key points for the sustainable growth of platform enterprises, which leave gaps for research in the future. A synthesis framework with seven propositions has been proposed, which can give scholars some ideas and directions worth exploring or delving into for future research. Future research can focus on these gaps and produce more suggestions for ways in which platform enterprises can maintain growth. For scholars, research on platforms is still an arduous task. Considering the complexity of the research on sustainable platform growth, we suggest conducting research from different perspectives or integrating multiple theories, which may lead to better conclusions.

5.2. Limitations

This study identified the challenges and coping strategies in the growth stage of platform enterprises by searching the relevant literature for content analysis, and only 200 articles were included in the analysis, so future research could include a wider range of studies to gain a more comprehensive understanding of the research topic of platform enterprise growth. In addition, this study did not combine quantitative analysis with measurement software such as cite space, and future research could consider a combination of qualitative and quantitative analysis to more comprehensively identify the knowledge structure and research trends of platform-based enterprise growth.

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