

Article

# Sustainability Condition of Open Innovation: Dynamic Growth of Alibaba from SME to Large Enterprise

Jinhyo Joseph Yun <sup>1,\*</sup>, Xiaofei Zhao <sup>1</sup>, KyungBae Park <sup>2</sup> and Lei Shi <sup>3</sup>

<sup>1</sup> Department of Open Innovation and Business Model, Open Innovation Academy of SOI, and DGIST, Daegu 42988, Korea; qiaoke@dgist.ac.kr

<sup>2</sup> Department of Business Administration, Sangji University, Wonju 26339, Korea; kbpark@sangji.ac.kr

<sup>3</sup> Department of Environmental Planning and Management, Tsinghua University, Beijing 100084, China; slone@tsinghua.edu.cn

\* Correspondence: jhyun@dgist.ac.kr

Received: 29 April 2020; Accepted: 20 May 2020; Published: 27 May 2020



**Abstract:** Research Question: Open innovation and the open business model exaggerate complexity (a transaction cost) in addition to the realization of emergence and its lock-in. Within a short period, Alibaba has become one of the global top e-commerce companies with several open innovation business models. Our research question was: “How could Alibaba become a global top e-commerce company in China in such a short time?” Research Method: We chose a deep interview method, participatory observation, and meta-analysis to answer this research question. Research Result: Alibaba has applied global, creative e-commerce business models through open innovation in a short time. In addition, it has overcome complexity—i.e., the cost of open innovation and the force that breaks down a company—through an open innovation-friendly culture. This is a “Jack-Ma style consumer confidence and new Guanxi culture”, a new and strong Chinese corporate culture. Alibaba has also undergone the expansion of its open business model feedback loop platform. This study investigated the expanded open business model feedback loop platform, the continuously strengthened open-innovation-friendly culture, and complexity, with the latter being the cost of open innovation, which was controlled by an open-innovation-friendly culture and open business model feedback loop.

**Keywords:** Alibaba; open innovation; complexity; open innovation culture; open business model feedback loop platform; sustainability

## 1. Introduction

Established in 1999, Alibaba is the dominant e-market in China, with a market share of more than 60%. Alibaba.com offers an open environment for small- and medium-sized enterprises (SMEs), which can join with minimum requirements [1]. As shown in Appendix A, Jack Ma started his first company, Haibo Translation Company, in 1992. Soon after, he started Alibaba and within the last 20 years the company has grown. In 2004, Alibaba.com became the world’s largest online business-to-business (B2B) marketplace for global trade, playing host to China’s leading domestic B2B trade communities [2]. Whereas the dot-com bubble in the 2000s destroyed many information technology (IT) companies in China, Alibaba overcame the crisis and has now grown into the world’s leading e-commerce company [3]. Alibaba is evolving not only as a Chinese e-commerce platform but also as a global electronic marketplace (GEM) platform, which began with the simple idea that enabled millions of Chinese SME suppliers to connect with overseas buyers online [4]. The rapid growth of online

consumer and e-business websites in China motivates the e-business ecosystem of Alibaba, including its dynamic evolutionary path [5].

Its competitors (Sina, Sohu, and NetEase) started their businesses at this time in large cities such as Beijing or Shanghai, and the chief executive officers (CEOs) of these companies came from prominent universities in the United States. Meanwhile, Alibaba started as a local company in Hangzhou, and its CEO, Jack Ma, graduated from Hangzhou Normal University after working as an English teacher. Today, however, among these companies, Alibaba is the only survivor and leads the global market.

With the development of mobile internet and finance, fraud risk has arisen in all shapes and sizes. In response to these threats, Alibaba introduced Fraud Risk Management (FRM) within the company under big data in 2015 [6]. FRM also meets Alibaba's primary business goal: to provide efficient B2B e-commerce solutions to SMEs in China and the rest of the world [7]. Alibaba possesses a value-added special e-market with a trust system, a search system, a payment system, several tools, and B2B and C2C markets [8].

In China, the great scope and depth of openness to science, technology, and innovation has significantly improved performance, which means that open innovation is relevant beyond science- and technology-based innovation [9]. In this study, we reveal some clues about factors that are needed for the sustainability of open innovation in the long term at the firm level in China [10].

The main objective of this study is to answer the following research question: "How could Alibaba become a global top e-commerce company in China in such a short period?"

## 2. Literature Review, Research Framework, Research Method, and Scope

### 2.1. Literature Review

#### 2.1.1. Open Innovation Dynamics

Open innovation means the creation of new values, which were produced through a combination of markets and technologies of different companies beyond the boundaries of companies, as well as the introduction of new and combined business models [11,12]. Even though open innovation research started at the firm level, it has expanded from individual actors in organizations through dyads and from inter-organizational networks to ecosystems and a national innovation system [13,14].

In addition, as information technology (IT) has spread across all industries, research on open innovation dynamic capabilities to allow firms to "sense" and "seize" outbound opportunities has become an additional factor in open innovation research [15–17]. Open innovation has configured self-sustainable system dynamics by creating a platform through a feedback loop [18,19]. For economic systems or sector-based innovation, including in individual companies, open innovation forms system dynamics and becomes the driving force of sustainable growth and development [20,21]. The phenomenon is that a new business model is continuously created during the process, wherein open innovation leads system dynamics, or industrial dynamics can be understood as the coevolution of open innovation and business model creation [22,23]. According to Nonaka and Toyama (2005), the creative routine of knowledge creation is also subject to the cyclical process of dynamic open innovation. The process of dynamic open innovation consists of three processes—an outside-in process, an inside-out process, and a coupled process—which all require the crossing of not only company boundaries but also regional boundaries [24,25]. Not only environmental factors, such as patent protection, technological turbulence, and transaction rates, but also diverse internal and external characteristics such as a collaborative culture or systems will be required for the success of open innovation dynamics [26,27]. With the acceleration of the Fourth Industrial Revolution, a paradigm shift from producer innovation to user or open innovation and collaborative innovation is rapidly occurring [28]. In open innovation dynamics, open collaboration has become a strong platform for growth in adjacencies at GE, Alibaba, and other companies [29]. In the evolutionary stages of a business ecosystem, work with innovators such as customers and suppliers to define a new value proposition around a seed innovation is a way to bring new ideas to the existing ecosystem [30].

### 2.1.2. Business Dynamics Feedback Loop

One of the important tools to drive sustainable development through open innovation is the open innovation platform, which includes a business dynamics feedback loop or within-functional and cross-functional exploration and exploitation [31–33]. The engine of corporate growth, which is realized as increasing returns and economic growth, comes from the business dynamics positive feedback loop, despite limits to lock-in [34]. The business dynamics feedback loop means that business growth, including sales growth, can be simulated by reinforcing the feedback loop through the dynamics of growth from diffusion [35].

Through the network effect of the business dynamics feedback loop (i.e., platforms), the world of increasing returns appears to be opposite to Alfred Marshall's world—that is, the world of diminishing returns [36]. More markets are operating on the basis of an open platform; even large companies cannot be freed from the dominance of an open platform [37]. In other words, a key tool that creates sustainable innovation through business model dynamics is the completion of the feedback loop through the reestablishment of missing linkages [38,39]. However, an open loop in the platform is a degenerate feedback Nash Equilibrium [40]. This means that an open loop in the platform shifts from the existing balance to a new one. There are two-sided network effects in a platform: first, even in the absence of competition, a firm can rationally invest in a product; second, distinct markets for content providers and end consumers can be identified; third, product coupling across markets can increase consumer welfare, even while it increases as a result of profits [41]. Even though it is doubtful that the complete removal of platform control can maintain its network effect, opening customer or provider markets as well as complementary markets through the open platform strategy accelerates network effects through the business dynamics feedback loop [32,42].

Platforms that have a business dynamics feedback loop provide an architecture to combine internal and external innovations in ways that create value throughout the chain of activities that deliver useful technology to the market [31]. A platform model paved the way for the success of companies that broke the existing order with the fastest growth; examples of such companies are Google, Amazon, Alibaba, Microsoft, Uber, Airbnb, and eBay [37]. Products and services that bring together groups of users in two-sided networks are platforms [43]. On the other hand, special two-sided networks, including two-sided markets and two-sided platforms, are characterized by cross-side network externalities between two types of participants. Further, as both sides are needed for the network to succeed, intermediaries face a “chicken-and-egg” problem [41]. As hardware/software networks and communications networks both exhibit positive adoption or network externalities, these networks are susceptible to under-utilization [44,45].

### 2.1.3. Complexity, or Transaction Cost: The Cost of Open Innovation

In open innovation, openness generates negative impacts on innovative performance, such as significant managerial challenges, financial and cognitive costs, or changes in knowledge leakages [9]. Because the complexity of new technologies often goes beyond the capabilities of individual companies, sometimes innovating companies cooperate with other firms and organizations to reduce the inherent uncertainties associated with a novel product [14]. Additionally, openness in the economy inevitably causes uncertainty or complexity [46]. Open innovation itself also causes complexity, or transaction cost, in the interaction between firms [18]. Thus, the relationship between innovative performance and the breadth or depth of open innovation has a reverse U-curve, which means that if open innovation increases beyond some level, the cost of open innovation (complexity) is higher than the benefits of open innovation, e.g., the emergence or the advantage of the first mover [47]. In addition, the creation of innovations often requires openness, but the commercialization of innovations requires protection; this is the openness paradox, another cost of open innovation [48,49]. Thus, the effects of collaboration breadth and depth, i.e., the effects of open innovation, on radical and incremental innovation performance are not much better [50]. Thus, the high open innovativeness of start-ups

is not necessarily associated with survival during the early stages of firm growth and entails a more complicated start-up process, i.e., complexity [51].

The organization of economic activity and the choice of market versus non-market allocation reveals a need to create a place for positive transaction costs, both with market failures and in conjunction with the market contraction of intermediate products [52]. However, the existence of vertical integration in an organization may result in a case wherein the costs of operating in a competitive market are not zero; an example of such costs is the sacrifice of emergence or creativeness [53]. Still, organizations are not substitutes for structuring efficient transactions when markets fail. They possess unique advantages for governing certain kinds of economic activities through logic that is different from that of a market [54]. The attempts of new institutional economics to explain organizational behavior solely in terms of agency, asymmetric information, transaction costs, opportunism, and other concepts drawn from neo-classical economics ignore key organizational mechanisms such as authority, identification, and coordination [55]. In other words, an organization is necessary, at a minimum level, to lessen the transaction cost that occurs outside a corporate organization. However, the new emerging class created through the coordination of an organization to overcome the bounded rationality of humans cannot be ignored [56,57]. A corporate organization can promote a new combination through cooperation rather than a simple reduction of transaction cost through its own innovation [58].

Open innovation can be viewed as an instance of how firms decide whether to develop innovations internally or partner with external actors, in accordance with the boundaries of the firm and openness in consideration of transaction cost, as well as bounded rationality [59]. Firms adopt selective revelation in open innovation because of the complexity or transaction cost that goes together with the emergence of openness [60]. In fact, being driven by a selfish motive only for oneself and displaying humanity for others to improve the apparent capability of showing human nature are the roots of capitalism [61].

#### 2.1.4. Open Innovation Culture: Giver or Altruist

In China's e-commerce sector, understanding, adaptation, and sharing of the local culture have high and particular importance [62]. Challenging topics in open innovation are the cultural issues that occur as a consequence of dealing with increased external contacts [63]. Open innovation benefits from a culture characterized by cosmopolitanism and openness for global interaction because involving people with diverse cultural backgrounds in the innovation process augments the ability to rapidly respond to changing markets (van Reine, 2016). Innovation cultures that are needed for open innovation are transdisciplinary and sub-organizational cultures with the imperative to pragmatically integrate anything desirable, necessary, useful, feasible, and appropriate [13,64]. Societal innovation culture focuses on factors of the internal culture of the organization such as trust, communication, creativity, the ability to learn, the tolerance of failures, and diversity, which can motivate cooperation with other organizations or customers [64]. Thus, a culture for open innovation can have diverse aspects, such as employees with a more "go-getting" personality, organizations or units that do not rely as heavily on their own technological competencies, organizations or units that are less concerned about losing control over technology, organizations or units that have a stronger technology-sensing capability, or organizations or units that perceive a higher degree of organizational risk-taking [65].

For continuous stable innovation and the creation of corporate performance, an open-innovation-friendly culture is needed [66]. Therefore, overcoming cultural barriers in the processes of open innovation through intermediaries is one of its key strategies [67]. Sharing the open innovation culture among various subjects connected to a corporate system, in addition to all the members of a company, can control the complexity caused by the open innovation of the company [68,69]. In other words, the culture that stimulates and sustains creativity and innovation—that is, the organizational culture that controls complexity and maintains open innovation—is one of the key factors that determine the success of open innovation [70]. A lower degree of heterogeneity among the concerned actors in the process of the open innovation of a platform, motivated by the open innovation culture, will increase the likelihood of successful business model innovation [71].

In particular, if a company plays the role of a giver, sharing its profits with other companies in a platform business model, the company can gain their trust, improve collaboration, and generate more profits through platform-based feedback [72,73]. In addition, according to a study that empirically analyzed the effect of individual characteristics on altruism in experiments on open innovation, altruism in the economic behavior of individuals enhances the psychological satisfaction of economic agents, encourages them to work harder, and allows them to achieve better work, thus leading to greater accomplishments [74–76]. Therefore, in an internet-based platform, collaboration with external agencies, such as customers or other firms, including CEO effects that support the collaboration of employees, is increasing [77,78]. The greater an individual's *tertius iungens* (that is, connection and orientation), the greater their involvement in innovation [79].

## 2.2. Research Framework

By leveraging digital business ecosystems for enterprise agility, diverse logics such as resource-abled capability, dynamic capability, or complexity logic, were developed in Alibaba [80]. Alibaba, like Uber and Airbnb, as a network orchestrator, has been able to create more value [81]. Researchers want to open the black box of Alibaba's digital business ecosystems, which have been a network orchestrator, as detailed in the research framework (see Figure 1).

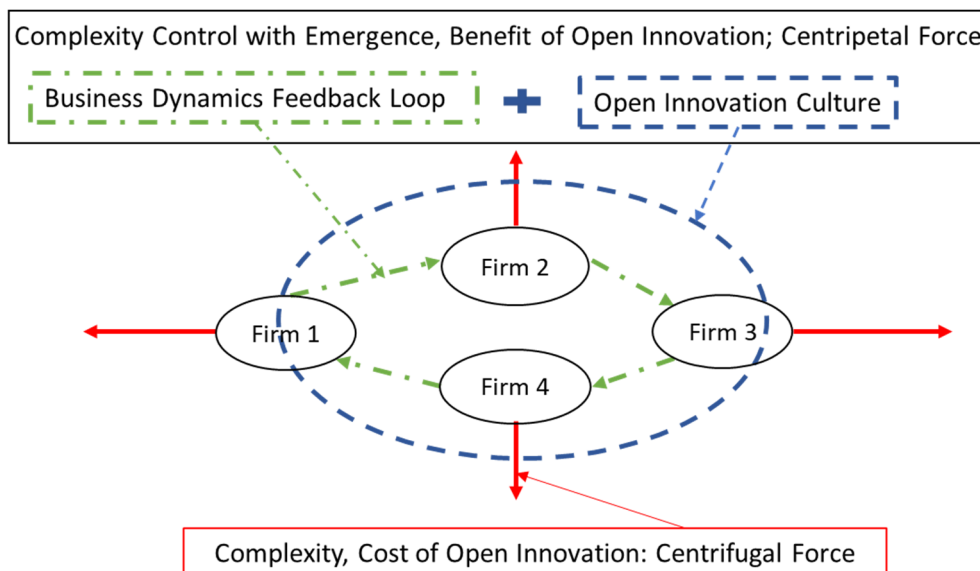


Figure 1. Research framework.

According to prior research, open innovation leads to an increase in complexity and emergence. Emergences of open innovation by SMEs can only occur with a strong and continuous focus on managing innovation to control complexity, because SMEs are more effective in using different OI practices simultaneously when they introduce new products to the market [82,83]. Emergence or benefits of open innovation can be continued by spreading the feedback loop of an open platform. Expanding the feedback system of open platforms allows a business that is newly added, by creating a virtuous circle in the entire feedback loop, to systemize emergence and partially control complexity (see Figure 1).

The complexity of open innovation, which is the centrifugal force of the firm, can be controlled during the spreading and expanding of the open innovation culture, as in Figure 1. The spread of open innovation culture will increase emergence as the result of the increase in the openness of a new business model. On the other hand, open-mindedness toward other companies and a rise in altruism promote trust-based collaboration to partially control the complexity of open innovation (see Figure 1).

This study analyzes the dynamic process of expanding the open platform feedback loop and open innovation culture, which are the centripetal forces of Alibaba, shown in the research framework (see Figure 1) from the point of view of motivating open innovation emergence and holding back on open innovation complexity. Open innovation culture can be understood as the output of the entrepreneur's central orchestrator role in the network of innovation partners [84]. Companies have to team up with other actors in the business system and build inter-organizational networks to support open innovation in system innovation contexts [85,86].

Alibaba has added new business models through open innovation and increased existing business models within just 20 years. Alibaba's growth is dynamically described in terms of continued emergence achieved by spreading the open platform feedback loop and the control of complexity. Moreover, the continuance of emergence and the control of complexity are analyzed through the expansion process of Alibaba's open innovation culture. Therefore, we studied the growth of Alibaba by analyzing the expansion of the business dynamics feedback loop and open innovation culture, in addition to the diverse complexities that Alibaba experienced during growth, as in Figure 1.

### 2.3. Research Method, and Scope

For this research, we analyzed the historical dynamics of Alibaba from 1997 to 2017. This study combines several diverse research methods. Firstly, the foundation of this research was established by analyzing previous studies. To establish the research framework for this study, an intensive literature review was carried out. We examined research on open innovation dynamics, the business dynamics feedback loop, open innovation culture, and the cost of open innovation (i.e., complexity), in addition to literature on Alibaba. Furthermore, we analyzed the transformation of the complexity of Ali-Cloud from 2017 to 2019 through news and online information.

Second, lectures by and interviews with Jack Ma (from 1999 to June 2017) from more than 10 books were analyzed through a qualitative meta-analysis method. Details are found in Appendix B. In business, meta-analysis has been used to assess the effectiveness of programs used to train employees and to guide practices for the reduction of absenteeism, turnover, and counterproductive behavior in empirical or qualitative ways [87]. Meta-analysis as a secondary rather than primary method is applied as a statistical method in medical studies [88] and it is also a useful qualitative research approach for analyzing the history of any firm, organization, businessperson, or agency [89]. We chose to perform a qualitative meta-analysis of Jack Ma's talks from 1999 to 2016 to discover characteristics of the culture of Alibaba during its growth using open innovation dynamics. Our primary goal in analyzing Jack Ma's talks was to find evidence of the Alibaba culture that was more objective than that gathered from interviewing him.

Third, we interviewed Alibaba consumers and employees from related companies inside and outside China using the semi-structured questionnaire given in Appendix C in addition to participatory observation of them. The semi-structured interview is designed to obtain subjective responses from persons regarding a particular situation or phenomenon that they have experienced [90]. This method is also useful for overcoming threats to validity and reliability and arriving at a conclusion that, although not objective at the time of its collection, can be made more objective after the fact by adding or comparing the interview results of several interviewees with other results of different research methods [91]. Semi-structured interviews are useful when researchers gather facts, attitudes, opinions, and data on topics together, as in the case of our research situations [92]. Questionnaires can be structured to add more qualitative aspects to quantitative data so as to give the research a more meaningful result, especially when research involves personal opinions such as research in e-commerce or the construction industry [93]. In-depth interviews based on the semi-structured questionnaire were conducted with several people, such as a researcher from the Alibaba research center in Beijing, a professor related to Alibaba in Beijing, and a director of Alibaba in Hangzhou, in addition to 11 customers in China like Appendix D.

Lastly, we carried out interviews with China Ali-Health customers and China drugstore owners in Nanjing on 21–24 September 2019, to examine the change in the complexity of Ali-Health.

### 3. Research Result

#### 3.1. Growth of Alibaba: From 18 Employees to Customers

##### 3.1.1. Alibaba Start-Up

The Alibaba start-up had three roots. First was the period during which Jack Ma established Hangzhou Haibo Translation Agency to provide the service of translation to businessmen, students, and engineers in Hangzhou in 1992. In addition, he also gave lectures on English. Jack was involved in intermediated transactions and retail trades to create profits to maintain the business, which later became the basic idea for the creation of Alibaba.

The second root was the period during which he founded China Yellow Pages in 1995 and started an online business. This was the first website creation company in China, and it created home pages for small- and medium-sized companies in Hangzhou, which provided the experience for Alibaba's entry into the e-commerce business.

Third, Ma worked in a Chinese government department and created initial e-commerce platforms for large companies based on 27 categories. The aforementioned experiences led to the foundation of Alibaba, a B2B platform company for small- and medium-sized companies in Hangzhou. He learned about transactions from the first experience, e-commerce for small- and medium-sized companies from the second, and transaction platforms from the third.

Alibaba's initial model was a single corporate-transaction platform based on Guanxi, the traditional Chinese culture of mutual trust and relationships based on the internal organization of a company. At the time, Ma set out his vision and shared it with the 18 co-founding members of the company: "Let's go together toward our goal: success". Jane Xiao, director of the Alibaba headquarters in Hangzhou, mentioned that there are 18 statues of milk cows built in the head office indicating the 18 founders and their bond. Currently, the culture of Alibaba is based on the employees who know each other (i.e., Guanxi). Jack Ma, who enjoys the novels of Jīn Yōng and reading the Tao Te Ching by Laozi, has imported their spirit and culture into the building of corporate culture and gradually, himself, has been a culture setter since its foundation.

At this time, all employees of Alibaba did not have common interests. So many employees were left behind when the firm became Alibaba, because of its high complexity. At this time, a feedback loop for Alibaba employees did not exist. Only the Guanxi culture that was emphasized by Ma could maintain 18 employees in Alibaba (Figure 2).

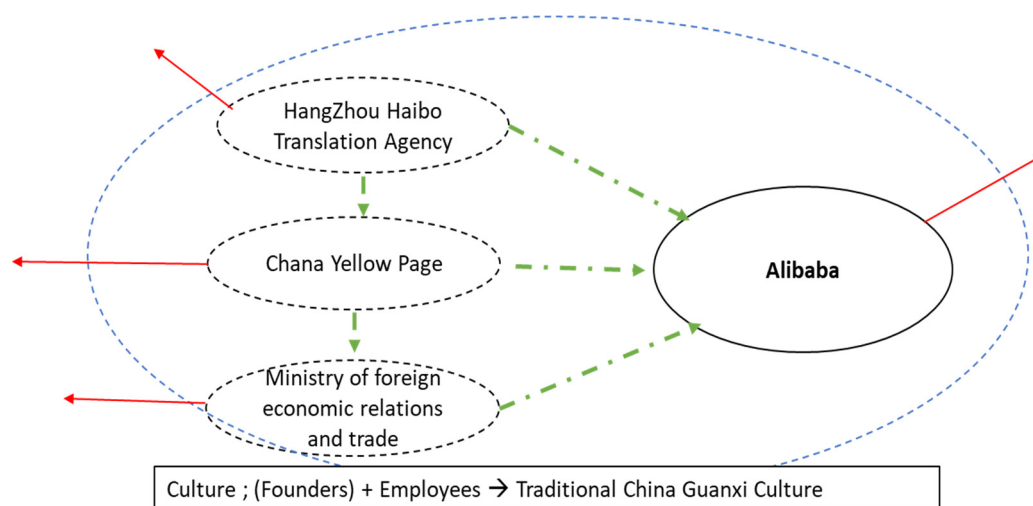
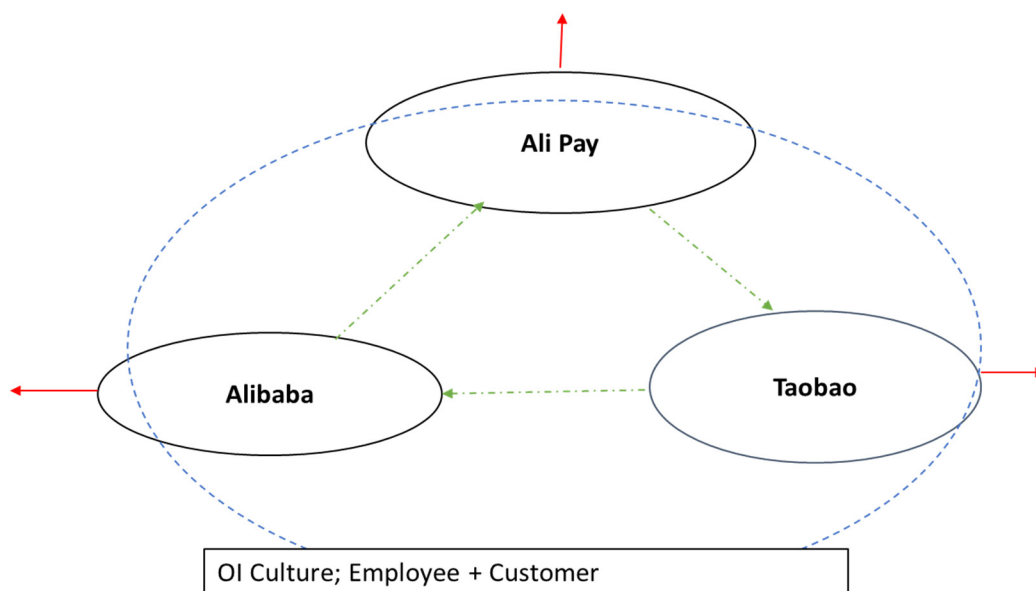


Figure 2. Alibaba start-up system. Source: developed by authors.

### 3.1.2. Taobao and Alipay

The initial platform of Alibaba, established in 1999, was an open B2B platform, meaning it connected companies for free. Taobao, a customer-to-customer (C2C), open, and free platform that connected consumers was added in May 2003. Furthermore, Alipay, an Internet payment system that supported the transaction of a B2B platform, was also added as an open platform in October 2003.

The increase in use of the Alibaba platform led to a wide use of Alipay, resulting in promotion of the use of Taobao, a C2C platform. Additionally, the increased use of Taobao feedback for the B2B platform process led to increased use of Alibaba. Unlike other e-commerce platforms such as Amazon, Alibaba is an open B2B platform that companies can freely use, while Taobao is an open C2C platform that consumers can also use freely. On the other hand, Alipay is an open platform with fees and can be used in various ways in addition to Alibaba. The open platforms are connected through a feedback loop, with a system wherein a virtuous circle, which allows them to strengthen each other, is accelerated (Figure 3). The virtuous circle allows the offset of each complexity or transaction cost of the two open platforms with free access and one open platform with fees. The combination of B2B and C2C models has grown through the business-to-business-to-consumer (B2B2C) model of Taobao.com.



**Figure 3.** Taobao and Alipay system dynamics. Source: developed by authors.

Interviewee Yao Wang, a private business owner, has said that more and more consumers want to pay with Alipay, and, recently, the majority of products from his shop were paid for using Alipay. Prof. Ying-Che Hsieh, another interviewee, said that, in his recent official trip to Beijing, he found that Alipay had become a key payment tool in offline transactions in China in addition to e-commerce. Mickey Chang, a Taiwanese former employee of an e-commerce company, said that many Taiwanese also used Taobao to buy Chinese products. Dawei Zhao, a Chinese engineer, frequently buys his preferred items, such as mobile phone cases and tobacco, from Taobao. Similarly, Chinese singer Sitong Liu easily buys cheap accessories for his performances from Taobao. Xiaolin Wang, a Chinese office worker, also often shops in Taobao because she has no time, even though there is a department store near her office.

Alibaba recently began focusing on the trust culture that stresses a customer-centered corporate culture and customer profits, and Ma focused on such establishment of an internal vision. This gave Alibaba an opportunity to accumulate an open innovation culture, a vision, and a consensus that can alleviate the complexity caused by open innovation (Figure 3). Ian Chang, a Taiwanese employee of Alibaba, said that the company has emphasized customer culture to its employees, including its Taiwanese employees, from the beginning of Alibaba.



### 3.2. Development of Alibaba: Expansion of Market Value

#### 3.2.1. Tmall and Ali Search System (eTao)

The company introduced a free e-commerce search platform in Taobao C2C and Alibaba B2B platforms in November 2005. Its new business models built a system dynamic connection with existing systems through a feedback loop. The system dynamics accelerated the dynamic growth of Alibaba’s entire system through new platforms, such as the Ali Searching System as well as the existing open innovation platform. According to interviewee C (a female), who has been selling caps for 14 years on Alibaba, the search system to find any Alibaba seller operated well and was useful to both sellers and buyers. Interviewee C also agreed with the usefulness of the Alibaba e-commerce search system.

Alibaba took over Yahoo China but did not combine the two companies, as illustrated by the high complexity in Figure 4. However, Alibaba reorganized with the Ali Search System in 2006 and allowed diverse consumers to find their desired products or enabled companies that wanted to connect with a small- and medium-sized company to access them through the Alibaba platform under growing complexity. In other words, the feedback loop controlled the complexity that originated from the mergers and acquisitions (M&A) open innovation of Yahoo China (Figure 4). During an early stage of Yahoo China’s merger with Alibaba, it was recognized that different corporate cultures and businesses had been combined. They were in conflict with each other, and the complexity of open innovation was thus heightened. The complexity of open innovation was higher than the emergence, the so-called search in e-commerce, until the e-commerce search system was established as part of expanding the feedback loop of an open e-commerce platform by eliminating Yahoo, which had long been a search engine, until it became an independent corporation, eTao, in 2010.

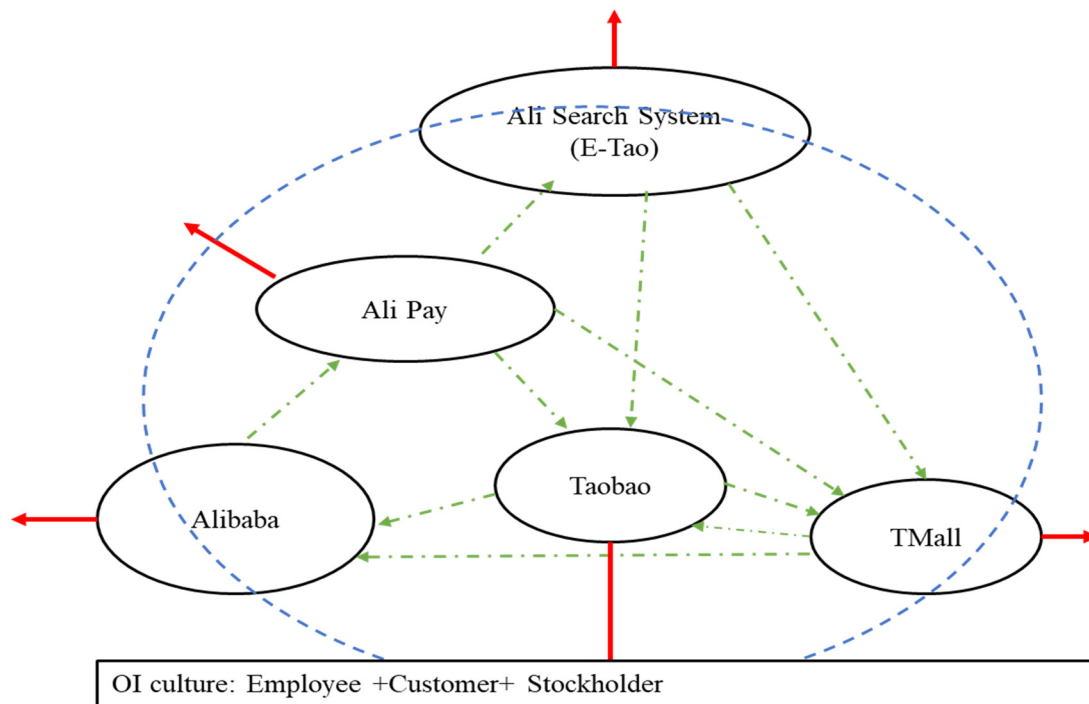


Figure 4. Tmall and Ali search engine (eTao). Source: developed by authors.

As Alibaba entered the growth stage, it built Tmall, a premium and paid C2C e-commerce platform in 2006, targeting high-level products and brand companies, in addition to Alibaba’s free search platform. The establishment of Tmall in 2006 gave new opportunities to companies whose capacity was built on B2B and C2C platforms. Furthermore, it paved for Alibaba a path toward being a new profit creation channel through e-commerce. Tmall’s introduction means that Alibaba is a secured free B2B and free C2C, along with e-commerce companies such as Amazon or eBay. Interviewee Jing

Cao, a housewife and an office worker, said that middle-income mothers purchased baby products such as strollers, diapers, and powder that were sold around the world from a reliable website, Tmall. Another interviewee, Yang Xu, a bank employee, said that she was a middle-income earner and bought expensive perfumes and bags from Tmall, paying for them using Alipay and subsequently receiving points. As illustrated in Figure 4, a small customer complained that the paying e-commerce, normally via a high-level e-commerce platform, increased the feedback loop system dynamics of Alibaba.

At the time, Alibaba was listed on Hong Kong’s stock exchange market and promoted the strategy of internally sharing its corporate culture with a focus on the interests of consumers, workers, and shareholders. In particular, the merger with Yahoo China was a combination of a commercial transaction company and an online search firm. The confusion and complexity caused by open innovation were thus significantly exacerbated. In 2007, while Alibaba was listed on the Hong Kong stock market, Ma promoted the open innovation cultural movement in various ways through meetings with organizations or departments to establish a wider internal culture in Alibaba, thus covering the interests of its shareholders beyond the advantages of its internal members and consumers (Yang & Lee, 2015, pp. 232–234). The spread of open culture for different sectors in the organization became a driving force to unite the groups of Yahoo and Alibaba through e-commerce search, as seen in Figure 4.

### 3.2.2. Ali Advertisement (Alimama) and Ali Cloud

As Alibaba introduced the Ali Advertisement (AD) system in 2007 (see Figure 5), sellers can now advertise their products on Alibaba, Taobao, or Tmall. Customers can also contact the AD platform to obtain consumer products during the search process and under a new payment system. As shown in Figure 5, Alimama and Ali Cloud drove complexities such as a large financial loss for Alibaba until 2016, because they were not similar to the existing Alibaba platform when they were introduced.

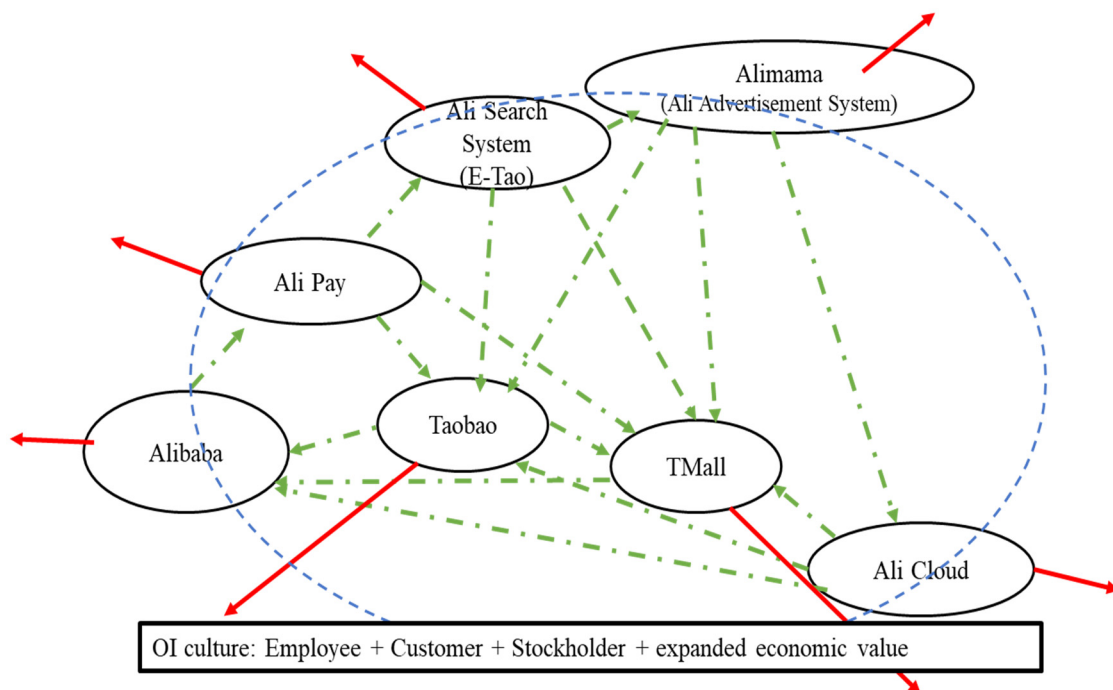


Figure 5. Ali Advertisement System (Alimama) and Ali Cloud System. Source: developed by authors.

However, the introduction of Ali Cloud in 2009 strengthened the e-commerce platforms for companies in the B2B or C2C platforms, allowing them to build and operate e-commerce. In fact, the introduction of Ali Advertisement reinforced the diverse e-commerce transactions connected through the Alibaba platform with content-based advertisements, promoted their interrelation, improved the content feedback loop of the Alibaba platform, and, finally, created significant revenues for

Taobao. In addition, Ali Cloud strengthened the sub-platforms connected with the Alibaba platform hardware-wise, thus enhancing the entire physical feedback loop of the platform. Ali Cloud is an investment in Alibaba's future revenues, a point that can be confirmed by the high investment goal for Ali Cloud set by Alibaba and the interviews with MingHan Cui, director of Ali Research Institute, and Lei Shi, who operated a research network with Alibaba and worked as a professor of Tsinghua University. Alibaba often talks about the shift from the information technology era to a data technology (DT) era. Alibaba looks to DT to help advance toward "C2B" or "consumer-to-business". For computing, Ali Cloud is the obvious direction for Alibaba, as DT, including big data, can help Chinese manufacturers improve communications throughout the supply chain to predict demand and thus potentially eliminate inventory. MingHan Cui, director of the Ali Research Institute, stressed that the future value of Ali Cloud in the Alibaba platform would be huge.

The additional connections of the new Ali system and the expansion of the feedback loop were strengthened by a corporate culture that emphasized new market profits for existing companies and consumers (Figure 5). Ma suggested the culture and vision of expanding economic values to offer opportunities for creating a new level of economic gains by sharing the data and calculation ability that Alibaba accumulated in the Ali Cloud with other people in order to increase the economic gains of everyone involved with e-commerce through the typical Alimama platform [94] (Alibaba Group, 2016, p. 38). They are promoted with a strategy to prevent complexity in advance, which may be due to the new business models and open innovation, as in Figure 5.

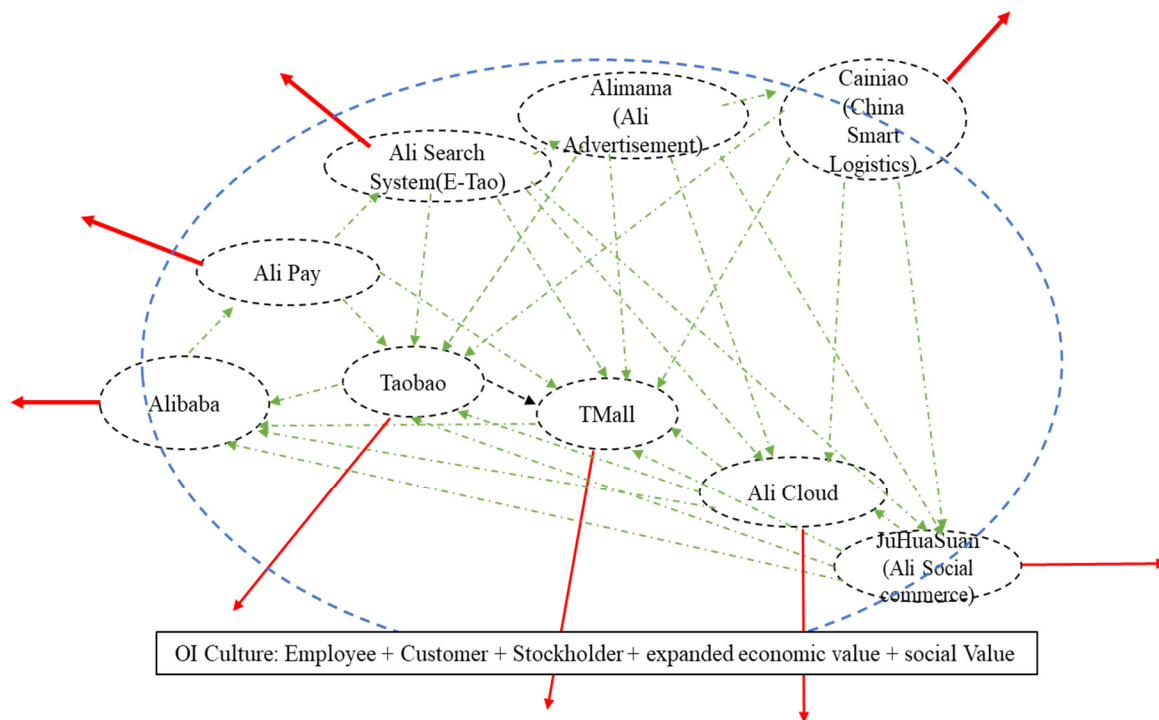
According to additional interviews and open data acquired in September 2019, in China Nanjing and Baidu Baike information on Ali Cloud, Ali Cloud became the third-largest cloud company in the world by providing for large public and private companies in China. These included 12306 China Railway, Sinopec, CNPC, and Taobao Double 11 shopping carnival, non-Chinese companies such as Philips, and small- and medium-sized enterprises. This means that Ali Cloud's centrifugal force was well controlled by the system dynamic feedback loop and expanded open innovation culture (Figure 5).

### 3.3. Sophistication of Alibaba: Growth with Social Value

#### 3.3.1. Ali Social Commerce and Ali Logistics

Alibaba added two open innovation platforms to the existing Alibaba system (see Figure 6). The addition of Ali Social Commerce (Juhuasuan) created new social values, such as the protection of disadvantaged rural groups in China and the prevention of environmental catastrophes, as well as its existing economic value through the largest product-focused, group-buying platform. Social commerce indicates an acceleration of the combination of e-commerce and SNS. By sharing the value of a good product between producers and consumers, Juhuasuan can independently create social value.

Moreover, the company built an open platform for logistics firms across China, leading to a significant increase in social values by aiding in the distribution platform for the socially vulnerable in the region. Furthermore, Alibaba's distribution platform plays an important role in improving the economy of the socially weak. Alibaba's logistics platform opens the company's warehouse storage system as a platform and provides a new opportunity for Chinese couriers, logistics companies, and the company itself. In addition, it provides new economic gains to rural areas or underdeveloped regions, creating social values to offer a better quality of life in China. According to field research in China in September 2019, Alibaba added Eleme, a type of smart delivery system, which is again motivating the Alibaba Logistics system in addition to increasing Ali-Health and other Alibaba system components.



**Figure 6.** Ali Social Commerce (Juhuasuan) and Ali Logistics (China Smart Logistics). Source: developed by authors.

At first, China Smart Logistics experienced a lot of opposition from existing logistics firms and the inconsistency of Alibaba's existing systems, exemplified by the fact that nearly 40% extends past the Alibaba culture boundary in Figure 6. Ali Social Commerce experienced similar opposition from inside Alibaba, for instance, Tmall in Figure 6. However, the feedback loop expansion of Alibaba's business model platform through Juhuasuan and Ali Logistics indicates the extension of the CBS structure, wherein customers lead the business, resulting in a connection with service providers, as Ma has mentioned

To date, Ma has emphasized Alibaba's new vision, value, and culture, which provide gains to society rather than just to Alibaba's employees. This means that even though a newly added business model conflicts with the interests of the existing business, if it creates useful social values, it becomes a driver toward higher openness for members. As Ma started to stress social values in training programs for employees and executives, he expressed the value of mutual openness for creating social values: "All people need to have an open mind to communicate with each other". Ma pointed out the improvement of social values by integrating social resources, emphasizing that Alibaba added a logistics platform as a business model with an open mind rather than an imperial attitude. This expanded open innovation culture and brought down the cost of open innovation, as shown in Figure 6.

### 3.3.2. Ali Rural Taobao and Ali-Health

In 2014, Alibaba invested in CITIC 21CN, a Hong-Kong-listed pharmaceutical data business and renamed it Alibaba Health. Alibaba Health seeks to profit from the inefficiencies of state-owned providers in the sector through several services, including making appointment bookings easier for patients, as well as making it easier for doctors, clinics, and consumers to access information and to order pharmaceuticals. This is a model that expands social values and creates economic values based on expansion by improving the efficiency of accessing medical services. The feedback loop of Alibaba's open innovation business model platform extends the social value of medical services through the e-commerce network by connecting the sale of medicine and medical supplies, including their consumption and using the existing logistics systems.

The Rural Taobao and Ali-Health created a lot of complexities at first because these two systems came out of e-commerce recently in China and the global economy. According to our interviews, the Alibaba research center director and normal customers of Alibaba did not like the inclusion of Ali-Health and Rural Taobao in the Alibaba system because they conflicted with the existing benefits of Alibaba, such as the location of Ali-Health and Rural Taobao (Figure 7).

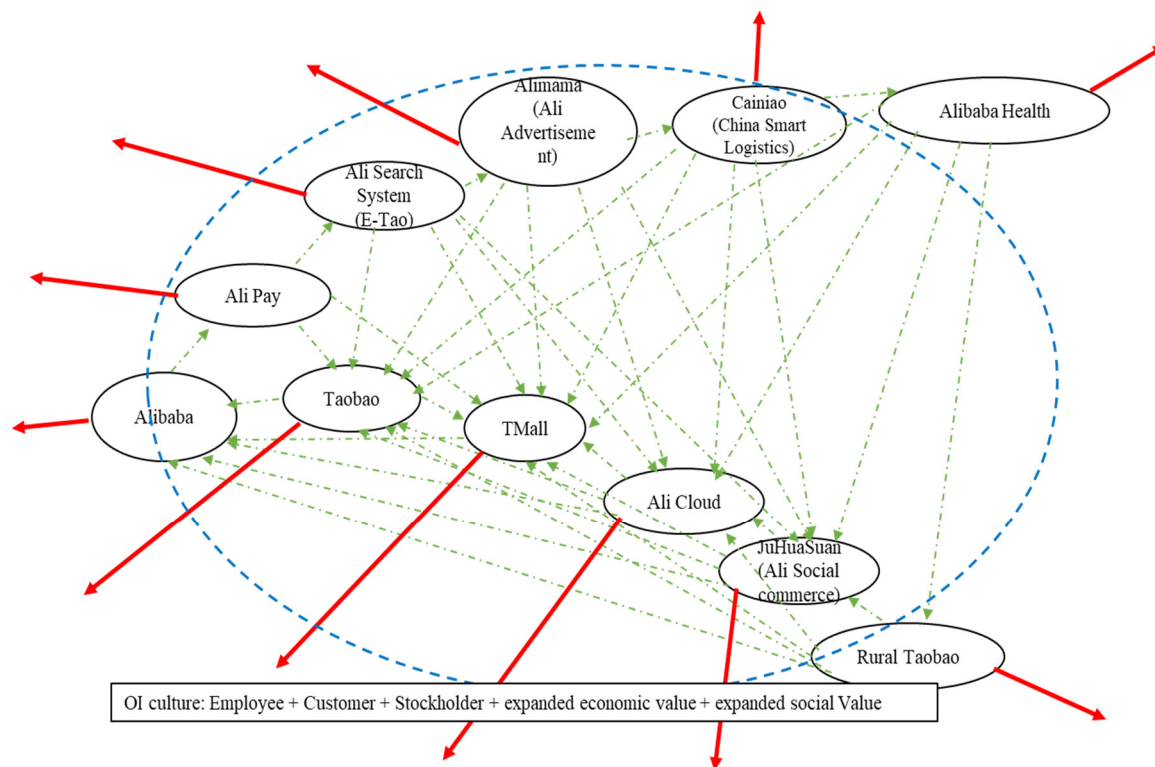


Figure 7. Rural Taobao (Ali Rural-Smart Farm) and Ali-Health. Source; developed by authors.

The connection of additional open innovation platforms such as Rural Taobao and Alibaba Health with the Alibaba system allowed for the creation of additional profits through the feedback loop, even though the company’s complexity increased at first. It is particularly meaningful that Rural Taobao and Alibaba Health added a new market that was not a target of the existing e-commerce market. They are business models that create additional social values in addition to the expanding market and social values. Unlike China’s other online entities (companies such as Tencent, Baidu, and Sina), Alibaba Group’s greatest and unique appeal lies in its huge e-commerce ecosystems with the expansion of platform feedback loops (see Figures 3–7).

The extension of social value creation and sharing expands with Alibaba’s open innovation culture, strengthening the handling of complexity caused by a new open innovation business model. In other words, Alibaba promoted an open innovation culture that accepts change, diversity, and stranger, new, minor areas such as the rural area and health area. Ma tried to integrate the expanded open innovation culture or value into the company’s human resource systems through internal speeches or training sessions. Alibaba developed its culture and vision as a platform company to build the Chinese economy, create social values, and improve the global economy and society rather than just earning money. Thus, even though diverse business platforms were added, the feedback of all platforms has been continuously expanded without an increase in transaction. Alibaba’s reutilization and expansion of open innovation culture and expansion of the feedback loop motivated the emergence of its open innovation platforms and controlled the complexity of the open innovation platforms.

#### 4. Discussion: Expansion of the Platform and Culture with Continuous OI

The methods of motivating emergence and controlling complexity, i.e., the cost of open innovation in Alibaba, were the expansion of both the open-platform feedback loop systems and the open innovation culture. The creation or addition of a new business model through open innovation increases complexity or uncertainty, as well as emergence from the perspective of companies. Therefore, companies should strategically exert efforts to maximize the emerging performance of a new business model through open innovation while controlling its complexity or uncertainty.

Alibaba has added many open innovation business models with system dynamics in a simple technology-market business model (e-commerce) within a short period. Through this process, Alibaba has created systems that allow business models to have a virtuous cycle through the establishment of a feedback loop. In addition, Alibaba continuously expands and develops its corporate culture to sustain corporate open innovation, systematically strengthening it through Ali Academy, Ali Day, Ali Competition, and Ali Team cultural events. These efforts were the driving factors for Alibaba to become a top global e-commerce firm within a short period.

Alibaba's 20-year experience of overcoming complexity—the cost of open innovation and continued re-emergence—is important in terms of aspects of open innovation strategy analysis. First, this company pursued open innovation at speed: it added new business models, such as mergers and acquisitions (M&A), attracted new talents, and made investments. The emergent performance achieved through the process is proven by its short-term growth. Second, even though Alibaba added various new business models that were not attempted by other e-commerce firms, such as the Ali Search Engine, Ali Advertisement platform, Ali SNS system, Alibaba Health, and Alibaba Entertainment, signs of risk due to increases in transaction costs or complexity did not occur. Third, the various business models that Alibaba added always connected to the feedback loop across the company's platform. Each business model was always linked to the business model platform of the entire Alibaba ecosystem with characteristics of open business models.

The dynamics of continuing emergence of open innovation and the control of its complexity in Alibaba were not achieved through Ma's management philosophy or decisions. They are the structural characteristics of the platforms and cultural assets developed by the large platform business model, Alibaba.

The Causal Model of Open Innovation Business Platform Growth is described in Figure 8 and Appendix E. The causal loop model in Figure 8 was developed in open innovation strategies and open innovation cultures from the causal model for open innovation with emergence and complexity that was developed for another firm case [95]. The asterisk-marked (in the table, those marked as \*\*\*) loops in Appendix E represent the most essential effects of "Institutionalization of OI Culture" for sustainable platform growth by preventing possible restrictions from "complexity by OI". As seen in Figure 8 and Appendix E, an increase in open innovation strategy could motivate performance by growing the platform or reinforcing the feedback loop of the platform. This happens when the firm is able to control the complexity of open innovation, which is being expanded through leadership for open innovation culture and the institutionalization of open innovation culture in the firm.

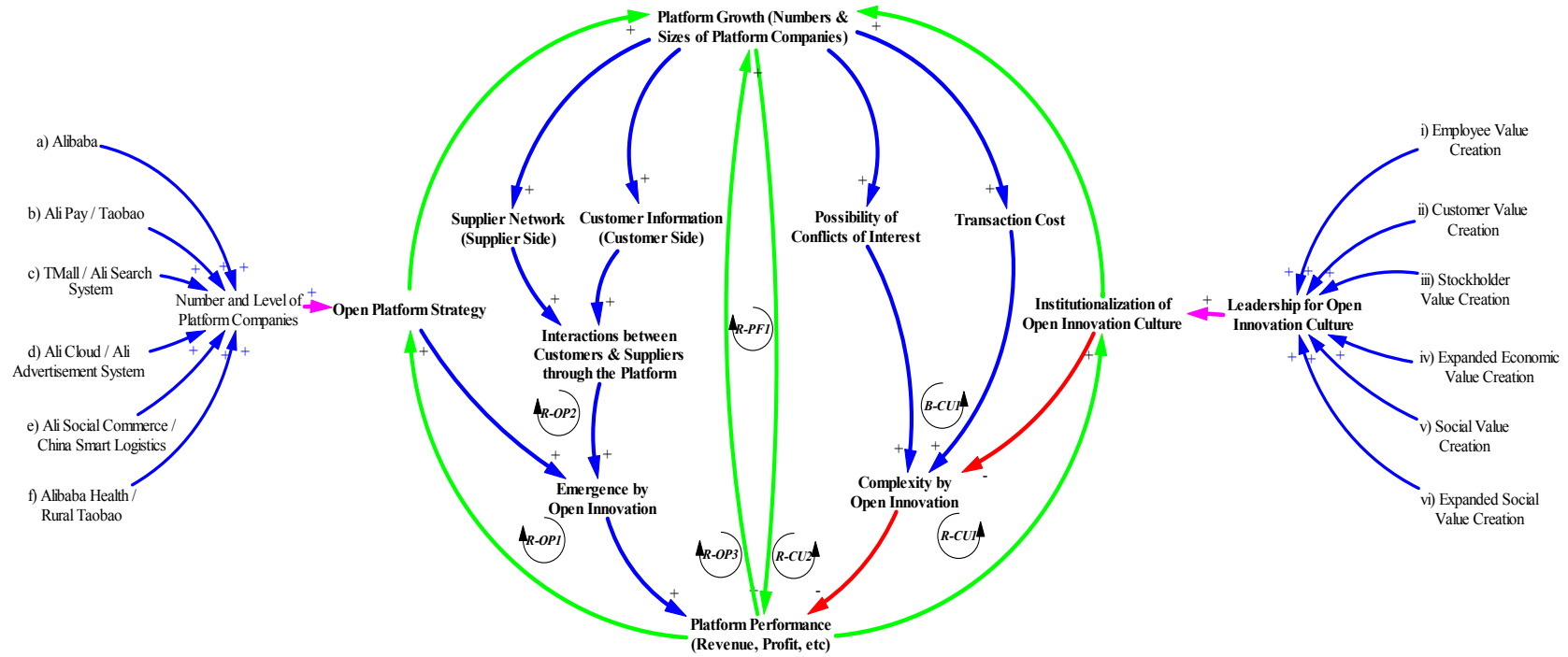


Figure 8. Causal model of open innovation business platform growth.

Open innovation can motivate innovation performance in two conditions: First, as shown on the left in Figure 8, open innovation should be expanded with system dynamic feedback loops to reinforce the positive effects of the total platform. Second, as shown on the right in Figure 8, the complexity or transaction cost of open innovation should be well controlled through the expansion of open innovation culture through powerful leadership and institutionalization for open innovation culture.

## 5. Conclusions

### 5.1. Implications

This study was a deep case study of Alibaba, concerning one very impressive case of the dynamics of open innovation and dynamic control of open innovation costs. This paper analyzed the open innovation dynamics of Alibaba from the 1997 B2B platform to 2017's Ali-Health. This research focused on three dimensions of Alibaba's open innovation dynamics: expansion of the business dynamic feedback loop, expansion of open innovation culture, and appearance and expansion of OI costs with the growth of open innovation. Through open innovation dynamics, Alibaba motivated the explosive emergence of e-commerce platforms. However, these dynamic open innovations also increased complexity, i.e. open innovation costs. According to our analysis, Alibaba effectively used expansion of the business dynamic feedback loop and open innovation culture to control open innovation costs in open innovation dynamics for 20 years.

### 5.2. Limitations and Future Research Topics

The first requirement is to conduct a static and horizontal analysis for each of the Alibaba platform components, such as concrete open innovation strategies, business model structure and contents, the main complexity that occurred in the platform components, and the open innovation culture that operated in the complexity situation. In fact, the role of information system (IS) capabilities in multisided platform (MSP) development is evolutionary in nature, and the antecedent IS capabilities, nature, and outcomes of MSP development can be dramatically different during the various stages of development [96]. This research focused on the dynamic approach taken by Alibaba. Additional research should involve static and horizontal analysis of each Alibaba platform component.

Second, further research should be conducted on opposing firms that introduced open innovation strategies but failed to control the cost of open innovation, that is, complexity. This additional research will better reveal the cost of open innovation, which was first introduced in this research through the discussed case study. The opposite cases should be selected from firms that were worldwide leaders in their industries but disappeared shortly after introducing M&A, partnerships, or technology licensing: examples include BlackBerry and Nokia. Because this research focused only on the dynamic evolution of the Alibaba platform, additional research on the cost of open innovation—that is, transaction cost or complexity—will show us more diverse ways to control the complexity that comes from open innovation.

Third, statistical research on the open innovation culture and the cost of open innovation is required to generalize the findings of this research. The relations between open innovation dynamics and the system feedback loop, open innovation culture, and complexity due to open innovation should be generalized by statistical research on a specific sector, region, or national innovation system. This research did not analyze the statistical data on open innovation cost or open innovation culture.

Fourth, we should analyze additional cases of open innovation cultures that reduce and control complexities and were motivated by the open innovation strategies of firms, such as M&A, partnership, and licensing technologies. Open innovation culture should be defined more concretely so that it can be measured and applied to control diverse complexities that are introduced by open innovation.



**Author Contributions:** J.J.Y. proposed this research topic, did deep interviews and participatory observations, and wrote all of this paper; X.Z. joined all the deep interviews and participatory observations with professor J.J.Y.; L.S. arranged and joined the deep interview with Alibaba employees in Beijing and Hangzhou. K.P. joined deep interview with Alibaba employees in Beijing and Hangzhou. All authors have read and agreed to the published version of the manuscript.

**Funding:** This work was supported by the DGIST R&D Program of the Ministry of Science and ICT (17-IT-01, 18-IT-01, 19-IT-01, 20-IT-10-02).

**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A

**Table A1.** Foundation and growth of Alibaba.

Year	Event	Description
1992	Haibo Translation Agency	Jack Ma operated a translation company in Hangzhou and started an offline transaction business to secure operating expenses.
1995	China Yellow Pages	Jack Ma founded this online company that created home pages for companies.
Dec. 1997	Ministry of Foreign Trade and Economic Co-operation (present Ministry of Commerce)	As a Chinese government organization, this built the platform for each industrial category with China Yellow Pages founders, including Jack Ma. As the platforms were mainly for large Chinese companies, the direction that the ministry wanted did not match that of Jack Ma's.
Mar. 1999	Alibaba	Alibaba, a B2B site, was officially established in Hangzhou.
Mar. 2002	ChengSinTong	Alibaba generated an online trading service with a membership system for small- and medium-sized companies in China.
May 2003	Taobao.com	Alibaba founded Taobao.com, a C2C site. It recruited about 50,000 members within 100 days after its establishment. About 90,000 products were displayed online. Taojanghai, an SNS, developed by Taobao.
Oct. 2003	Alipay	Alibaba created Zhifubao, an independent online payment system. Alibaba's Yu'E Bao online mutual fund (2013) offers small loans, customer deposit money management, etc. Sesame Credit Management provides the credit ratings of consumers and merchants to third parties. Mybank (2015), an online Internet bank and peer-to-peer lending business.
Nov. 2005	Shopping search portal (eTao, 2010)	Alibaba took over Yahoo China in August 2005 and started developing a new Yahoo search engine from November 2005. Alibaba established eTao, its subsidiary and a shopping search portal, as an exclusive search engine for Alibaba in October 2010. Alibaba offered diverse information to customers through Aliwangwang, the Alibaba-exclusive online messenger, in real time. Ali Flavor, the internal communication network of Alibaba.
2006	Tmall (Tianmiao)	A premium online shopping mall.
2007	Alimama	Alibaba's affiliate in charge of online advertisements and marketing.
2007	Alisoft	This company develops, maintains, and manages SW for Alibaba. An Alibaba subsidiary that offered electronic business management, customer management, and accounting management systems to small- and medium-sized exporters for free.
Nov. 2007	Listed on the Hong Kong stock market	Delisted from the stock exchange in February 2012.
Sep. 2009	Ali Cloud	Alibaba established Ali Cloud, a cloud service company. The company accumulated big data capacity.
Mar. 2010	1688.com	Alibaba's wholesale transaction platform.
Apr. 2010	AliExpress	Alibaba's retail shopping mall for global consumers. Generally, Russian, Brazilian, and American consumers used this shopping mall. Global consumers can purchase various products at a reasonable price from Chinese wholesalers and manufacturers through AliExpress.
Sep. 2010	Juhuasuan	A social commerce platform where consumer groups purchase products.
2013	China Smart Logistic Network (Cainiao)	Cainiao and Alibaba hold 48% of its stakes. This Chinese logistics platform company was promoted to build the China Smart Logistics Network by 2020.
Jan. 2014	Alibaba Health	Alibaba entered the medical and health care industries through M&A and built a medical service network platform in combination with the car-sharing service of DD Echu and an e-commerce business for medicine and medical supplies.
Sep. 2014	Listed on the American Exchange	Alibaba, except for Alipay, was listed on the American Exchange.
Oct. 2014	Rural Taobao	Alibaba connects the agricultural products from rural areas of China with Chinese cities. Updated in June 2017. Nianhuojie is held on December 23, when many Chinese agricultural products are consumed by citizens, following the Singles' Day (or Guanggun Jie) and Double 12. The first Nianhuojie event was held in 2013.

## Appendix B

Table A2. List of books that includes lectures, conversations, and interviews with Jack Ma.

Number	Books	Lectures, Conversations, and Interviews with Jack Ma
1	Liu, Shiyong & Peng, Zheng (2010). <i>Who knows Jack Ma?</i> . Beijing: China CITIC Press.	Including three speeches from Jack Ma and direct and indirect interviews.
2	Alibaba Group (Eds.) (Trans.) (2013) <i>Jack Ma, Inner Conversation 2; 18 unpublished speeches and 9 inner letters</i> . Hangzhou: Alibaba Group.	18 unpublished speeches from 2010–2013. 9 inner letters from 2011–2013.
3	Jan, Yean (Trans.) (2013). <i>Jack Ma, my life philosophy: 12 lectures for the young generation</i> . Shenzhen: ShenzhenKougSa.	12 lectures by Jack Ma.
4	Alibaba Group (Eds.) (Trans.) (2015b). <i>Internet era now start: Jack Ma, inner conversation 2.0</i> . Beijing: Red Flag Press.	16 inner lectures, questions and answers. 2 interviews from 2010–2012.
5	Yang, Lin Bwon & Lee, Sang (Trans.) (2015). <i>Jack Ma with cheap shoes: 27 key times in the success history of Alibaba</i> . Beijing: ChunHaMunHa.	Direct and indirect interviews with Jack Ma.
6	Chun, We (Trans.) (2015). <i>This is Jack Ma</i> . Zhejiang; Zhejiang People Press.	Jack Ma's secretary wrote this book on the basis of participatory observation in addition to several interviews with Ma.
7	Erisman, Porter (2015). <i>Alibaba's World: How a remarkable Chinese company is changing the face of global business</i> . New York: MacMillan.	Interview with former vice president of Alibaba and company observations. He also proposed 40 points from his experience working with Alibaba.
8	Alibaba Group (Eds.) (Trans.) (2015a). <i>Jack Ma, inner conversation: Trust and transparency</i> . Hangzhou: Alibaba Group.	Speeches or lectures by Jack Ma in 2002 (one), 2007 (six), 2008 (seven), and 2009 (two).
9	Alibaba Group (Eds.) (Trans.) (2016). <i>Jack Ma, the future I saw: WEI LAI YI LAI</i> . Hangzhou: Alibaba Group.	37 lectures by Jack Ma. Seven conversations with Jack Ma.
10	Clark, Duncan (2016). <i>Alibaba: The house that Jack Ma built</i> . New York: HarperCollins Publishers.	Several direct or indirect parts of interviews with Jack Ma.
11	Lowrey, Ying (Ed.) (2016) <i>The Alibaba way: Unleashing grassroots entrepreneurship to build the world's most innovative Internet company</i> . New York: McGraw-Hill	Indirect interview with Jack Ma written by Alibaba's employees in several chapters.

## Appendix C Semi-Structured Questionnaire for Deep Interview and Participatory Observation

- 1-1. Please describe your individual relation with Alibaba.  
( )
- 1-2. Alibaba is very important in my individual life.  
(1) No, (2) A Little, (3) Yes, (4) Very, (5) Extremely.
- 2-1. Please describe the systemic connections among Alibaba organizations.  
( )
- 2-2. Alibaba has systemic connections among Alibaba organizations.  
(1) No, (2) A Little, (3) Yes, (4) Very, (5) Extremely.
- 3-1. Please introduce the dynamics of Alibaba culture that you have felt or experienced.  
( )
- 3-2. Alibaba has changed in firm culture dynamically.  
(1) No, (2) A Little, (3) Yes, (4) Very, (5) Extremely.
- 4-1. Please introduce conflicts among Alibaba sub-organizations that you knew or experienced.  
( )
- 4-2. There are conflicts among Alibaba sub-organizations that act against the revenues of Alibaba.  
(1) No, (2) A Little, (3) Yes, (4) Very, (5) Extremely.

## Appendix D

Table A3. Interviewee lists, including data, interviewee names, and main contents.

No.	Date	Interviewee Name	Main Contents
1	26 Sep. 2017	Ian Chang (employee of the Taiwanese branch of Alibaba)	He mentioned the foundation of Alibaba, the character of Jack Ma before the foundation, as well as the history, growth, and main business of ARI Group, Taobao, Tmall, Alipay, Ali Cloud, AliExpress, and Ali Entertainment. In addition, as a branch employee of Alibaba, he shared its corporate culture and education programs.
2	26 Sep. 2017	Mickey Chang (employee of one of the top five Taiwanese e-commerce firms)	His company is a Taiwanese competitor of Alibaba and ranks fourth in the nation. For political reasons, many Taiwanese dislike Taobao. In addition, it is thought that it is difficult to buy products through Taobao as a Taiwanese. However, there has been a recent increase in people wanting to buy a Chinese product or do a wholesale transaction using Taobao.
3	27 Sep. 2017	Prof. Ying-Che Hsieh	He discussed the growth of Alibaba as a global top e-commerce company in terms of open innovation. He frequently goes on business trips to mainland China due to a product collaboration with Tsinghua University. These days, as many people use Alipay; when he meets with friends, they tend to pay for the meal because paying with Alipay is more convenient for restaurant owners.
4	7 Oct. 2017	Yao Wang (owning a private business)	He frequently uses Alipay as a small business owner because an increasing amount of people request to pay with Alipay.
5	8 Oct. 2017	Xiaolin Wang (employee of the Jilin branch of Toyota)	As a full-time office worker, she has no time to shop. As such, she buys clothes or cosmetics from Taobao or Tmall.
6	9 Oct. 2017	Sitong Liu (singer for Jilin Song and Dance Ensemble)	There are not many upmarket performance clothes or accessories in Jilin markets. Through Taobao, she frequently buys diverse products at a low price.
7	12 Oct. 2017	Dawei Zhao (engineer)	This young man mainly buys mobile phone cases and tobacco cases on Taobao. In addition, as his father farms, he also uses this system to compare prices of agricultural products to sell his farm products. He checked if there was a private institute offering Rural Taobao in Jilin.
8	13 Oct. 2017	Yang Xu (bank employee)	As a teller, her income is not low. She frequently buys products in Tmall because she can get expensive/luxurious products (perfume or designer bags) there. She also uses Alipay because she can earn points such as Naver Pay and exchange them for products.
9	13 Oct. 2017	Xu Wang (manager of McDonald's)	She likes spicy foods but Jilin does not offer many spicy foods, so she buys spicy Wuhan duck, shabu-shabu, and special snacks from other areas through Taobao.
10	13 Oct. 2017	Jing Cao (office worker)	As a mother, she prefers German strollers, Australian powders, and Japanese diapers over similar Chinese products, so she uses Tmall.
11	8 Jan. 2018	MingHan Cui	As a new project manager in the Alibaba research center in Beijing, he reviewed the entire dynamic change in Alibaba business models, including the expansion of Alibaba business models and, in particular, the recent addition of a business model.
12	9 Jan. 2018	Lei Shi	As a professor of Tsinghua University, he mentioned the understanding of the external perspective in China of Alibaba business models and the process of spreading the business models taught by research groups rather than Chinese consumers and Alibaba members.
13	11 Jan. 2018	Jane Xiao	As the marketing director of Alibaba in Hangzhou, she reviewed the past and present corporate culture and the internal dynamics.
14	12 Jan. 2018	OOO (Cap seller)	This middle-aged woman, identified as interviewee C, makes and sells caps in Taobao. She has manufactured and sold caps for the past 14 years and currently still does this in her luxury apartment. She can deliver bulk purchases of caps in Hangzhou.

## Appendix E

Table A4. Feedback loops of open innovation business growth.

Feedback	Feedback Effect	Path
<R> 'Platform' Self-Reinforcing (R-PF1): Reinforcing	Mutual Reinforcing between Platform Growth and Its Performance	Platform Growth $\uparrow$ $\rightarrow$ Platform Performance $\uparrow$ $\rightarrow$ Platform $\uparrow$
<R> 'Open Platform Strategy' Self-Reinforcing 1 (R-OP1): Reinforcing	Mutual Reinforcing between Open Platform Strategy, Emergence by OI, and Platform Performance	Open Platform Strategy $\uparrow$ $\rightarrow$ Emergence by OI $\uparrow$ $\rightarrow$ Platform Performance $\uparrow$ $\rightarrow$ Open Platform Strategy $\uparrow$
<R> 'Open Platform Strategy' Self-Reinforcing 2 (R-OP2): Reinforcing	Mutual Reinforcing between Open Platform Strategy, Platform Growth, Emergence by OI, and Platform Performance	Open Platform Strategy $\uparrow$ $\rightarrow$ Platform Growth $\uparrow$ $\rightarrow$ Supply Network and Customer Information $\uparrow$ $\rightarrow$ Interactions between Customers and Suppliers $\uparrow$ $\rightarrow$ Emergence by OI $\uparrow$ $\rightarrow$ Platform Performance $\uparrow$ $\rightarrow$ Open Platform Strategy $\uparrow$
<R> 'OI Platform Strategy' Self-Reinforcing 3 (R-OP3): Reinforcing	Mutual Reinforcing between Open Platform Strategy, Platform Growth, and Platform Performance	Open Platform Strategy $\uparrow$ $\rightarrow$ Platform Growth $\uparrow$ $\rightarrow$ Platform Performance $\uparrow$ $\rightarrow$ Open Platform Strategy $\uparrow$
*** <R> 'OI Culture' Reinforcing 1 (R-CU1): Reinforcing of Growth through the usage of 'Institutionalization of OI Culture'	Reinforcing of Whole Growth Process using Institutionalization of OI Culture: Mutual Reinforcing between Ins. of OI Culture, Complexity by OI, and Platform Performance	Institutionalization of Open Innovation Culture $\uparrow$ $\rightarrow$ Complexity by OI $\downarrow$ $\rightarrow$ Platform Performance $\uparrow$ $\rightarrow$ Institutionalization of Open Innovation Culture $\uparrow$
*** <B> 'OI Culture' Restriction 1 because of 'Complexity' (B-Cu1): Balancing	Self-Restriction between OI Culture, Platform Growth, Complexity by OI, and Performance	Institutionalization of Open Innovation Culture $\uparrow$ $\rightarrow$ Platform Growth $\uparrow$ $\rightarrow$ Possibility of Conflicts of Interest and Transaction Cost $\uparrow$ $\rightarrow$ Complexity by OI $\uparrow$ $\rightarrow$ Platform Performance $\downarrow$ $\rightarrow$ Institutionalization of Open Innovation Culture $\downarrow$
<R> 'OI Culture' Reinforcing 2 (R-CU2): Reinforcing between Ins. of OI Culture, Platform Growth, and Platform Performance	Mutual Reinforcing between Ins. of OI Culture, Platform Growth, and Platform Performance	Institutionalization of Open Innovation Culture $\uparrow$ $\rightarrow$ Platform Growth $\uparrow$ $\rightarrow$ Platform Performance $\uparrow$ $\rightarrow$ Institutionalization of Open Innovation Culture $\uparrow$
*** <R> 'Early Setup of Ins. of OI Culture' Reinforcing (R-CU2): Desirable Effects of Early Setup of Institutionalization of OI Culture	Desirable Effects of Early Setup of Institutionalization of OI Culture	(A) Early Setup of Ins. of OI Culture $\uparrow$ $\rightarrow$ Institutionalization of Open Innovation Culture $\uparrow$ $\rightarrow$ Complexity by OI $\downarrow$ $\rightarrow$ Platform Performance $\uparrow$ $\rightarrow$ Institutionalization of Open Innovation Culture $\uparrow$ (B) Early Setup of Ins. of OI Culture $\uparrow$ $\rightarrow$ Institutionalization of Open Innovation Culture $\uparrow$ $\rightarrow$ Platform Growth $\uparrow$ $\rightarrow$ Platform Performance $\uparrow$ $\rightarrow$ Institutionalization of Open Innovation Culture $\uparrow$

Note: please note that asterisk-marked (\*\*\*) loops represent the most essential effects of "Institutionalization of OI Culture" for platform growth by preventing possible restrictions from "complexity" by open innovation.

## References

- Zhao, J.; Wang, S.; Huang, W.V. A study of B2B e-market in China: E-commerce process perspective. *Inf. Manag.* **2008**, *45*, 242–248. [CrossRef]
- Hu, Q.; Wu, X.; Wang, C.K. Lessons from Alibaba. com: Government's role in electronic contracting. *info* **2004**, *6*, 298–307. [CrossRef]
- Clark, D. *Alibaba: The House That Jack Ma Built*; HarperCollins Publishers: New York, NY, USA, 2018.
- Guo, J.; Lam, I.H.; Lei, I.; Guan, X.; Iong, P.H.; Ieong, M.C. Alibaba international: Building a global electronic marketplace. In Proceedings of the ICEBE'06. IEEE International Conference on e-Business Engineering, Sanghai, Chian, 24–26 October 2006; pp. 545–548.
- Huang, L.; Hu, G.; Lu, X. E-business ecosystem and its evolutionary path: The case of the Alibaba group in china. *Pac. Asia J. Assoc. Inf. Syst.* **2009**, *1*. [CrossRef]

6. Chen, J.; Tao, Y.; Wang, H.; Chen, T. Big data based fraud risk management at Alibaba. *J. Financ. Data Sci.* **2015**, *1*, 1–10. [[CrossRef](#)]
7. Lai, S.-L. Chinese entrepreneurship in the Internet age: Lessons from Alibaba. com. *World Acad. Sci. Eng. Technol.* **2010**, *72*, 405–411.
8. Qing, H. A model for value-added e-market provisioning: Case Study from Alibaba. com. In Proceedings of the FGCNS'08. 2nd International Conference on Future Generation Communication and Networking Symposia, Sanya, China, 13–15 December 2008; pp. 47–52.
9. Chen, J.; Chen, Y.; Vanhaverbeke, W. The influence of scope, depth, and orientation of external technology sources on the innovative performance of Chinese firms. *Technovation* **2011**, *31*, 362–373. [[CrossRef](#)]
10. West, J.; Vanhaverbeke, W.; Chesbrough, H. Open innovation: A research agenda. *Open Innov. Res. A New Paradig.* **2006**, 285–307.
11. Chesbrough, H.W. The era of open innovation. *Manag. Innov. Chang.* **2006**, *127*, 34–41.
12. Chesbrough, H. Business model innovation: Opportunities and barriers. *Long Range Plan.* **2010**, *43*, 354–363. [[CrossRef](#)]
13. Van de Vrande, V.; Vanhaverbeke, W.; Gassmann, O. Broadening the scope of open innovation: Past research, current state and future directions. *Int. J. Technol. Manag.* **2010**, *52*, 221–235. [[CrossRef](#)]
14. Vanhaverbeke, W.; Cloudt, M. Open innovation in value networks. *Open Innov. Res. A New Paradig.* **2006**, 258–281.
15. Teece, D.J. Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strateg. Manag. J.* **2007**, *28*, 1319–1350. [[CrossRef](#)]
16. Witt, U. Capitalism as a complex adaptive system and its growth. *J. Open Innov. Technol. Mark. Complex.* **2017**, *3*, 12. [[CrossRef](#)]
17. West, J.; Salter, A.; Vanhaverbeke, W.; Chesbrough, H. *Open Innovation: The Next Decade*; Elsevier: Amsterdam, The Netherlands, 2014.
18. Yun, J.J.; Won, D.; Park, K. Dynamics from open innovation to evolutionary change. *J. Open Innov. Technol. Mark. Complex.* **2016**, *2*, 7. [[CrossRef](#)]
19. Yun, J.J.; Cooke, P.; Park, J. *Evolution and Variety in Complex Geographies and Enterprise Policies*; Taylor & Francis: Oxfordshire, UK, 2017.
20. Yun, J.J. How do we conquer the growth limits of capitalism? Schumpeterian Dynamics of Open Innovation. *J. Open Innov. Technol. Mark. Complex.* **2015**, *1*, 17. [[CrossRef](#)]
21. Yun, J.J.; Won, D.; Hwang, B.; Kang, J.; Kim, D. Analysing and simulating the effects of open innovation policies: Application of the results to Cambodia. *Sci. Public Policy* **2015**, *42*, 743–760. [[CrossRef](#)]
22. Yun, J.J.; Won, D.; Jeong, E.; Park, K.; Yang, J.; Park, J. The relationship between technology, business model, and market in autonomous car and intelligent robot industries. *Technol. Forecast. Soc. Chang.* **2016**, *103*, 142–155. [[CrossRef](#)]
23. Christensen, J.F.; Olesen, M.H.; Kjær, J.S. The industrial dynamics of Open Innovation—Evidence from the transformation of consumer electronics. *Res. Policy* **2005**, *34*, 1533–1549. [[CrossRef](#)]
24. Gassmann, O.; Enkel, E. Towards a theory of open innovation: Three core process archetypes. In *R&D Management Conference Proceeding*; 2004.
25. Belussi, F.; Sammarra, A.; Sedita, S.R. Learning at the boundaries in an “Open Regional Innovation System”: A focus on firms’ innovation strategies in the Emilia Romagna life science industry. *Res. Policy* **2010**, *39*, 710–721. [[CrossRef](#)]
26. Huizingh, E.K. Open innovation: State of the art and future perspectives. *Technovation* **2011**, *31*, 2–9. [[CrossRef](#)]
27. Lichtenthaler, U. Outbound open innovation and its effect on firm performance: Examining environmental influences. *RD Manag.* **2009**, *39*, 317–330. [[CrossRef](#)]
28. Baldwin, C.; Von Hippel, E. Modeling a paradigm shift: From producer innovation to user and open collaborative innovation. *Organ. Sci.* **2011**, *22*, 1399–1417. [[CrossRef](#)]
29. Idelchik, M.; Kogan, S. GE’s open collaboration model. *Res. Technol. Manag.* **2012**, *55*, 28–31. [[CrossRef](#)]
30. Moore, J.F. Predators and prey: A new ecology of competition. *Harv. Bus. Rev.* **1993**, *71*, 75–86.
31. Chesbrough, H. Open platform innovation: Creating value from internal and external innovation. *Manag. Runtime Technol.* **2003**, *7*, 5.

32. Boudreau, K. Open platform strategies and innovation: Granting access vs. devolving control. *Manag. Sci.* **2010**, *56*, 1849–1872. [[CrossRef](#)]
33. Li, Y.; Vanhaverbeke, W.; Schoenmakers, W. Exploration and exploitation in innovation: Reframing the interpretation. *Creat. Innov. Manag.* **2008**, *17*, 107–126. [[CrossRef](#)]
34. Sterman, J. *Business Dynamics*; Irwin/McGraw-Hill c2000: Boston, MA, USA, 2010.
35. Morecroft, J.D. *Strategic Modelling and Business Dynamics: A Feedback Systems Approach*; John Wiley & Sons: Hoboken, NJ, USA, 2015.
36. Arthur, B. Increasing Returns and the Two Worlds of Business. *Harv. Bus. Rev.* **1996**, *74*, 100–109.
37. Parker, G.G.; Van Alstyne, M.W.; Choudary, S.P. *Platform Revolution: How Networked Markets are Transforming the Economy—and How to Make Them Work for You*; WW Norton & Company: New York, NY, USA, 2016.
38. Cavalcante, S.; Kesting, P.; Ulhøi, J. Business model dynamics and innovation:(re) establishing the missing linkages. *Manag. Decis.* **2011**, *49*, 1327–1342. [[CrossRef](#)]
39. De Reuver, M.; Bouwman, H.; Maclnnes, I. Business model dynamics: A case survey. *J. Theor. Appl. Electron. Commer. Res.* **2009**, *4*, 1–11. [[CrossRef](#)]
40. Fershtman, C. Identification of classes of differential games for which the open loop is a degenerate feedback Nash equilibrium. *J. Optim. Theory Appl.* **1987**, *55*, 217–231. [[CrossRef](#)]
41. Parker, G.G.; Van Alstyne, M.W. Two-sided network effects: A theory of information product design. *Manag. Sci.* **2005**, *51*, 1494–1504. [[CrossRef](#)]
42. Gawer, A.; Henderson, R. Platform owner entry and innovation in complementary markets: Evidence from Intel. *J. Econ. Manag. Strategy* **2007**, *16*, 1–34. [[CrossRef](#)]
43. Eisenmann, T.; Parker, G.; Van Alstyne, M.W. Strategies for two-sided markets. *Harv. Bus. Rev.* **2006**, *84*, 92.
44. Katz, M.L.; Shapiro, C. Systems competition and network effects. *J. Econ. Perspect.* **1994**, *8*, 93–115. [[CrossRef](#)]
45. Katz, M.L.; Shapiro, C. Network externalities, competition, and compatibility. *Am. Econ. Rev.* **1985**, *75*, 424–440.
46. Arthur, W.B. Complexity in economic and financial markets: Behind the physical institutions and technologies of the marketplace lie the beliefs and expectations of real human beings. *Complexity* **1995**, *1*, 20–25. [[CrossRef](#)]
47. Laursen, K.; Salter, A. Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms. *Strateg. Manag. J.* **2006**, *27*, 131–150. [[CrossRef](#)]
48. Laursen, K.; Salter, A.J. The paradox of openness: Appropriability, external search and collaboration. *Res. Policy* **2014**, *43*, 867–878. [[CrossRef](#)]
49. West, J.; Gallagher, S. Challenges of open innovation: The paradox of firm investment in open-source software. *RD Manag.* **2006**, *36*, 319–331. [[CrossRef](#)]
50. Kobarg, S.; Stumpf-Wollersheim, J.; Welpel, I.M. More is not always better: Effects of collaboration breadth and depth on radical and incremental innovation performance at the project level. *Res. Policy* **2019**, *48*, 1–10. [[CrossRef](#)]
51. Hyytinen, A.; Pajarinen, M.; Rouvinen, P. Does innovativeness reduce startup survival rates? *J. Bus. Ventur.* **2015**, *30*, 564–581. [[CrossRef](#)]
52. Tadelis, S.; Williamson, O.E. Transaction cost economics. *Handb. Organ. Econ.* **2012**, 159–193. [[CrossRef](#)]
53. Arrow, K.J. The organization of economic activity: Issues pertinent to the choice of market versus nonmarket allocation. *Anal. Eval. Public Expend. Ppb Syst.* **1969**, *1*, 59–73.
54. Ghoshal, S.; Moran, P. Bad for practice: A critique of the transaction cost theory. *Acad. Manag. Rev.* **1996**, *21*, 13–47. [[CrossRef](#)]
55. Simon, H.A. Organizations and markets. *J. Econ. Perspect.* **1991**, *5*, 25–44. [[CrossRef](#)]
56. Simon, H.A. Theories of bounded rationality. *Decis. Organ.* **1972**, *1*, 161–176.
57. Simon, H.A. Bounded rationality and organizational learning. *Organ. Sci.* **1991**, *2*, 125–134. [[CrossRef](#)]
58. Hill, C.W. Cooperation, opportunism, and the invisible hand: Implications for transaction cost theory. *Acad. Manag. Rev.* **1990**, *15*, 500–513. [[CrossRef](#)]
59. Dahlander, L.; Gann, D.M. How open is innovation? *Res. Policy* **2010**, *39*, 699–709. [[CrossRef](#)]
60. Henkel, J.; Schöberl, S.; Alexy, O. The emergence of openness: How and why firms adopt selective revealing in open innovation. *Res. Policy* **2014**, *43*, 879–890. [[CrossRef](#)]
61. Smith, A. *The Theory of Moral Sentiments*; Penguin: London, UK, 2010.
62. Wang, X. Foreign direct investment and innovation in China's e-commerce sector. *J. Asian Econ.* **2012**, *23*, 288–301. [[CrossRef](#)]

63. Van de Vrande, V.; De Jong, J.P.; Vanhaverbeke, W.; De Rochemont, M. Open innovation in SMEs: Trends, motives and management challenges. *Technovation* **2009**, *29*, 423–437. [[CrossRef](#)]
64. Weis, B.X. *From Idea to Innovation: A Handbook for Inventors, Decision Makers and Organizations*; Springer: Cham, Switzerland, 2014.
65. Herzog, P. *Open and Closed Innovation: Different Cultures for Different Strategies*; Springer Science & Business Media: Berlin, Germany, 2011.
66. Yun, J.J.; Yun, J.J.; Park, K.; Park, K.; Yang, J.; Yang, J.; Jung, W.; Jung, W. The philosophy of “open innovation” Historical development of the philosophy of open innovation and its reflection from Taoism. *J. Sci. Technol. Policy Manag.* **2016**, *7*, 134–153. [[CrossRef](#)]
67. Aquilani, B.; Abbate, T.; Codini, A. Overcoming cultural barriers in open innovation processes through intermediaries: A theoretical framework. *Knowl. Manag. Res. Pract.* **2017**, *15*, 447–459. [[CrossRef](#)]
68. Gassmann, O.; Enkel, E.; Chesbrough, H. The future of open innovation. *RD Manag.* **2010**, *40*, 213–221. [[CrossRef](#)]
69. Van der Meer, H. Open innovation—the Dutch treat: Challenges in thinking in business models. *Creat. Innov. Manag.* **2007**, *16*, 192–202. [[CrossRef](#)]
70. Martins, E.; Terblanche, F. Building organisational culture that stimulates creativity and innovation. *Eur. J. Innov. Manag.* **2003**, *6*, 64–74. [[CrossRef](#)]
71. Berglund, H.; Sandström, C. Business model innovation from an open systems perspective: Structural challenges and managerial solutions. *Int. J. Prod. Dev.* **2013**, *18*, 274–285. [[CrossRef](#)]
72. Grant, A.M. *Give and Take: A Revolutionary Approach to Success*; Penguin: London, UK, 2013.
73. Grant, A.M.; Mayer, D.M. Good soldiers and good actors: Prosocial and impression management motives as interactive predictors of affiliative citizenship behaviors. *J. Appl. Psychol.* **2009**, *94*, 900. [[CrossRef](#)]
74. Andreoni, J.; Harbaugh, W.T.; Vesterlund, L. Altruism in experiments. In *Behavioural and Experimental Economics*; Springer: Cham, Switzerland, 2010; pp. 6–13.
75. Simon, H.A. Altruism and economics. *Am. Econ. Rev.* **1993**, *83*, 156–161.
76. Giuliani, E.; Morrison, A.; Pietrobelli, C.; Rabellotti, R. Who are the researchers that are collaborating with industry? An analysis of the wine sectors in Chile, South Africa and Italy. *Res. Policy* **2010**, *39*, 748–761. [[CrossRef](#)]
77. Rhee, J.; Zhao, X.; Kim, C. Effects of HRM practices on Chinese firms’ organizational performance: The moderating effect of CEO support. *Asian Soc. Sci.* **2014**, *10*, 210. [[CrossRef](#)]
78. Sawhney, M.; Verona, G.; Prandelli, E. Collaborating to create: The Internet as a platform for customer engagement in product innovation. *J. Interact. Mark.* **2005**, *19*, 4–17. [[CrossRef](#)]
79. Obstfeld, D. Social networks, the tertius iungens orientation, and involvement in innovation. *Adm. Sci. Q.* **2005**, *50*, 100–130. [[CrossRef](#)]
80. Tan, B.; Pan, S.L.; Lu, X.; Huang, L. Leveraging digital business ecosystems for enterprise agility: The tri-logic development strategy of Alibaba. com. *ICIS 2009 Proc.* **2009**, 171.
81. Libert, B.; Wind, Y.; Fenley, M. What Airbnb, Uber, and Alibaba have in common. *Harv. Bus. Rev.* **2014**, 11.
82. Brunswicker, S.; Vanhaverbeke, W. Open innovation in small and medium-sized enterprises (SMEs): External knowledge sourcing strategies and internal organizational facilitators. *J. Small Bus. Manag.* **2015**, *53*, 1241–1263. [[CrossRef](#)]
83. Spithoven, A.; Vanhaverbeke, W.; Roijackers, N. Open innovation practices in SMEs and large enterprises. *Small Bus. Econ.* **2013**, *41*, 537–562. [[CrossRef](#)]
84. Vanhaverbeke, W. *Managing Open Innovation in SMEs*; Cambridge University Press: Cambridge, UK, 2017.
85. Vanhaverbeke, W. The interorganizational context of open innovation. *Open Innov. Res. A New Paradig.* **2006**, 205–219.
86. Maula, M.; Keil, T.; Salmenkaita, J. Open Innovation in Systemic Innovation Contexts [w:]. In *Open Innovation: Researching a New Paradigm*; Chesbrough, H., Vanhaverbek, W., West, J., Eds.; Oxford University Press: Oxford, UK, 2006.
87. Borenstein, M.; Hedges, L.V.; Higgins, J.P.; Rothstein, H.R. *Introduction to Meta-Analysis*; John Wiley & Sons: Hoboken, NJ, USA, 2011.
88. Hedges, L.V.; Olkin, I. *Statistical Methods for Meta-Analysis*; Academic press: Cambridge, MA, USA, 2014.
89. Glass, G.V. Primary, secondary, and meta-analysis of research. *Educ. Res.* **1976**, *5*, 3–8. [[CrossRef](#)]

90. McIntosh, M.J.; Morse, J.M. Situating and constructing diversity in semi-structured interviews. *Glob. Qual. Nurs. Res.* **2015**, *2*, 1–12. [[CrossRef](#)] [[PubMed](#)]
91. Barriball, K.L.; While, A. Collecting data using a semi-structured interview: A discussion paper. *J. Adv. Nurs. Inst. Subscr.* **1994**, *19*, 328–335. [[CrossRef](#)] [[PubMed](#)]
92. Horton, J.; Macve, R.; Struyven, G. Qualitative research: Experiences in using semi-structured interviews. In *The Real Life Guide to Accounting Research*; Elsevier: Amsterdam, The Netherlands, 2004; pp. 339–357.
93. Adejimi, A.; Oyediran, O.; Ogunsanmi, E. Employing qualitatively enriched semi structured questionnaire in evaluating ICT impact on Nigerian 'construction chain integration'. *Built Hum. Environ. Rev.* **2010**, *3*, 49–62.
94. Afuah, A. *Business Model Innovation: Concepts, Analysis, and Cases*; Routledge: Abingdon-on-Thames, UK, 2014.
95. Yun, J.J.; Lee, M.; Park, K.; Zhao, X. Open Innovation and Serial Entrepreneurs. *Sustainability* **2019**, *11*, 5055. [[CrossRef](#)]
96. Tan, B.; Pan, S.L.; Lu, X.; Huang, L. The role of IS capabilities in the development of multi-sided platforms: The digital ecosystem strategy of Alibaba. *com. J. Assoc. Inf. Syst.* **2015**, *16*, 248. [[CrossRef](#)]



© 2020 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).