

New Development of Traditional Industrial Clusters in China: Virtual Industrial Eco-clusters

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Abstract—Traditional industrial clusters (TICs) have encountered many challenges in the Internet age. Due to geographical restrictions, TICs have high cross-regional cooperation costs and cannot meet the efficiency requirements of economic globalization. Some of TICs in China are evolving into Virtual industrial eco-clusters. Member companies of VIECs virtually aggregate on the Internet and they are conducive to improving external economies of scale and reducing transaction costs. In VIECs, the core platform companies have a large number of users and other resources. Through the empowerment model, companies within VIECs can share resources with one another like ecosystems. In VIECs, the boundaries of companies are unclear and every company acts as a module. Consumers actively participate in production and other value-creation processes. The supply-to-production model ensures the balance between supply and demand which helps to reduce the amount of stock and reduce production costs. Communitization of users makes relations between the company and the consumer transferring from one-way value transmission to bi-directional value transmission. The sales volume of a product depends on the degree of stability of the relationship between users or companies in the communities, no longer subjecting to a passive product lifecycle. All these features will help companies in VIECs to achieve sustainable competitiveness in the Internet era.

Keywords—*traditional industrial cluster; virtual industrial eco-clusters; empowerment model; modularization of division of labor; user-centered value-creative process*

I. INTRODUCTION

TICs have encountered many new challenges in the Internet era. The Internet has accelerated the process of economic globalization. An important issue to consider when TICs participate in the global division of labor is collaboration costs. Due to geographical restrictions, TICs have high cross-regional cooperation costs and cannot meet the efficiency requirements of economic globalization. With the development of Internet, especially the mobile Internet, the TIC has evolved into a new form: the VIEC. The VIEC refers to the virtual aggregation of enterprises through the Internet rather than the geographical location.

In China, many Internet-based VIECs have been formed and are gradually expanding. They usually gather around leading platform companies through Internet. Large companies with a great numbers of users, especially platform

companies, are trying to establish their own VIECs so as to achieve sustainable development. They generally have super applications which can satisfy some of users' basic needs, and gather a large number of users. A VIEC is like an ecosystem. Each "species" member of the system performs its duties and interweaves with one another to form a complete value network. Materials, energy, and information flow through this system and circulate.

In VIECs, members of the "species" can be divided into the following categories according to their positioning:

- **Leading populations:** Leading populations in VIECs are the core platform companies which generally are the leaders and rule makers of VIECs. By providing platforms and monitoring services, they play roles of providing, integrating and coordinating resources in VIECs.
- **Key populations:** Key populations in VIECs are the key companies which are usually the second most important participants except the core platform companies. Key companies usually are leading companies in their fields and can form sub-VIECs around them.
- **Supporting populations:** Supporting populations in VIECs are the supporting companies such as logistics companies, financial institutions, telecommunication service providers and related government agencies which provide various support services for VIECs.
- **Parasitic populations:** Parasitic populations in VIECs are the parasitic companies such as technology outsourcers, consulting service providers, which are parasitic on the VIECs.

VIECs have the same advantages of TICs, such as talent gathering and resource sharing. At the mean time they also have the characteristics of virtualization and ecologicalization (see "Fig. 1"). Virtualization mainly refers to the fact that members of VIECs gather through Internet, no longer subjecting to geographical location as TICs. Geospatial distance brings two kinds of cooperation costs: transportation costs and information interaction costs. VIECs can effectively reduce the cooperation costs of members in the clusters.

Ecologicalization of VIECs mainly means that they form ecological closed loops on the Internet. The upstream and downstream industrial chains are connected to make full use of online resources in order to make all kinds of resources circulating inside VIECs. Companies within VIECs will

dynamically adapt to the surrounding environment. The core platform companies have a huge amount of users and other resources, which will attract a large number of other companies to gather on their platforms.

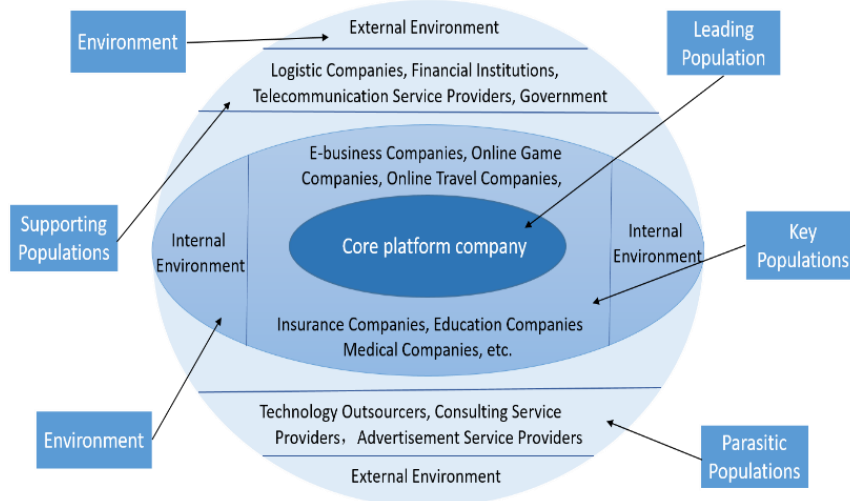


Fig. 1. Ecosystem of VIECs.

II. THE GENERATION OF PLATFORM COMPANIES

Internet platform companies in China often have super internet applications which attract a great many users and other resources. The generation of these super internet applications makes possible the formation of VIECs.

How do Internet platform companies form in China? The answer lies in the trend of centralization of Internet. The nature of the Internet is decentralized, emphasizing personality and freedom of expression. Traditional hegemony of discourse seems to have been subverted. But the reality is that the Internet is dominated by "some highly-linked nodes (or central nodes). These nodes, such as Yahoo or Amazon, have a very high visibility – wherever we go. We can see links to these nodes." [1] The scarcity of attention resources and the vast amount of information on the Internet is a contradiction. It is impossible for one person to spend unlimited time to find desired information. Therefore, Internet users need convenient and efficient accesses to trusted information. Users thus will gradually gather around some top companies. As David Hesmondhalgh predicted early, the industrial transformation brought about by this digitization process has failed to promote the democratization and decentralization of the Internet society. Instead, the internet industry to become increasingly centralized [3].

III. EMPOWERMENT MODEL OF VIECS

A. Empowerment Model of VIECs

Abbreviations and acronyms used in the text for the first time should be defined, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use

abbreviations in the title or heads unless they are unavoidable. The core platform companies in the VIECs have accumulated plenty of resources. Users, technical R&D capabilities, financial strength and regulatory system can be regarded as parts of infrastructure of the Internet economy. Core platform companies generally get plenty of users and other resources through basic services generally free of charge. In order to maximize their own resource advantages, core platform companies that have excess resources will look for partners in the relevant industry and empower their partners to improve the industrial chain and build a complete ecosystem.

In general, the core platform companies will have super Internet applications which are able to meet the user's some basic needs, such as social needs, shopping needs, financial needs, entertainment needs and so on. Super Internet applications aggregate a lot of users and other resources. Some excess users and other resources will be imported into partners' application via hyperlinks or other means.

Also R&D, financial and knowledge resources will be shared with one another among companies in VIECs. The process of value co-creation is as follows: The core platform companies attract a large number of users and other resources due to their value → Resources are shared with key companies in VIECs → Users trust the recommended companies → Users pay for the new services → Users experience this service → The new company gets feedback from users → Users' feedback influence reputation of the core platform companies and the recommended companies. In addition, supporting companies and parasitic companies in VIECs, such as government regulatory agencies, consulting companies, etc., will also empower the core platform companies and the key companies (see "Fig. 2").

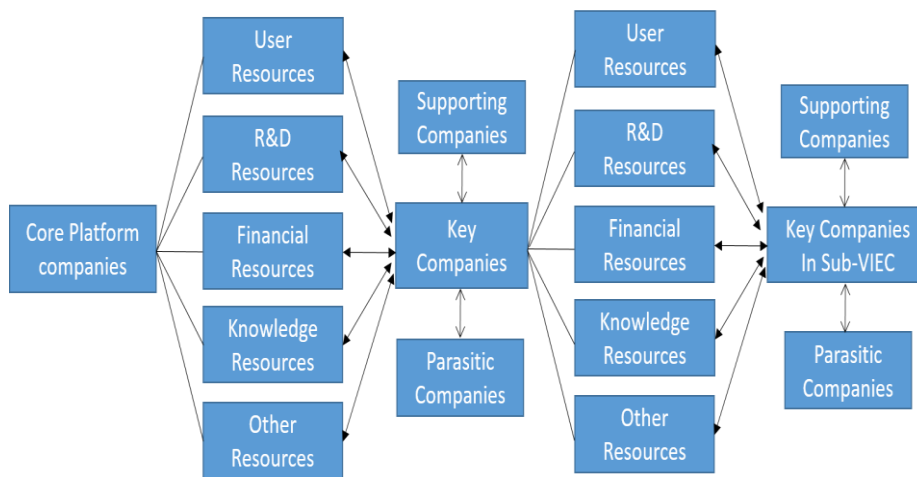


Fig. 2. Empowerment model of a VIEC.

B. The Essence of Empowerment Model: Cooperating Efficiently Through Internet to Achieve External Economies of Scale and Reduce Transaction Cost

An important advantage of TICs is that it can bring external economies of scale [4] [5]. VIECs strengthen their external economies of scale. External economies of scale make it easier for companies entering industrial clusters to gain competitive advantage [6]. What is the root cause of external economies of scale? The division of labor plays a decisive role in increasing labor productivity [7]. If there is no division of labor and production is only carried out in a self-sufficient production mode, the level of labor productivity will not be greatly improved. Allyn Young (1928) mentioned that the increase in the level of division of labor has led to an increase in productivity and a deeper level of professionalism of producers, which has led to economic growth [8].

In addition to exchange of external resources such as technology and users, enterprises in VIECs will also receive intangible benefits from other companies in VIECs, such as respect, reputation and care. The economic exchange focuses on Extrinsic Benefits, while intangible benefits exchange mainly reflects intrinsic rewards [9]. These exchanges can reconfigure resources within VIECs and member companies can make the most of these resources and quickly seize the market.

Reducing transaction costs is another advantage of TICs. Since companies in VIECs are aggregated by the Internet, they can further reduce transportation costs, communication costs, and other transaction costs. Specialized production leads to the narrowness of professional knowledge. In the process of production, companies must cooperate with other companies to produce the final product. Therefore, transaction and collaboration costs are inevitable.

Due to incomplete information and lack of resources, single company is not able to allocate resources to achieve external economies of scale. Inter-firm transactions may also have problems of market disequilibrium such as opportunism and moral hazard issues. VIECs can mostly solve these

problems. As mentioned above, they can increase external scale effects and reduce transaction costs, and can obtain effective information to improve the companies' abilities of forecasting and adapting to market changes. These cannot be achieved by any individual companies [10]. VIECs are essentially about mutual cooperation. With relationships companies can easily have repetitive transaction. The relationships are with "reciprocity", "mutual forbearance" and "trust" [11].

IV. FEATURES OF VIECS

Traditionally, companies gather at a certain geographical location through natural aggregation or policy aggregation. As the number of member companies increases, they will gradually develop into industrial clusters. TICs generally experience two stages of the expansion: "quantity expansion phase" and "quality-improvement phase" [12]. TICs surely contribute a lot to local economies. But with the development of the Internet, TICs have developed into a new phase: VIECs. Generally VIECs has the following features.

A. User-centered Value-creation Processes

In TICs, enterprises dominate the process of designing, producing and marketing. Users have to passively accept the products of enterprises. The enterprise plays a central role in the value-creation process. The enterprise decides what to produce and how to design and market. Users do not participate in this process. This kind of value-creation chain is called "propulsion model" [13]. The value-creation chain is mainly led by upstream manufacturers. After being produced, the products are gradually pushed to the downstream customers through levels of agents. Users are in a weak position of passive acceptance. The level of information integration between them is very low. TICs are usually unable to deal with changes in demand from consumers. The stock is unnecessarily high. However, In VIECs, this mode of production is difficult to continue since users become growingly important in the value-creation chain. The process of value creation is no longer linear. Users actively participate in the design, production, and sales process. The boundaries of traditional enterprises are broken.

User-centricity means paying attention to users' power and improving user experience. Let satisfying users' needs be the goal of product design, production and sales. Enterprises must not only stick to customer-centered principle in the value creation process, but also regard users as the most fundamental source of business value [14]. Users' comment on products circulating on the Internet directly affects the image, market value and sales of the brand. The communication between enterprises and users and between users and users becomes more convenient. The relationship between enterprises and users becomes more open and constructive. Each step of the company's value creation has the close involvement of users, and individuals and companies have an equal market position (see "Fig. 3").

In TICs, enterprises' work on R&D, manufacturing, and marketing are all closed up into the enterprises. A few experts play a key role in the value-making chain of products. The company pays much attention to asset management and operates inefficiently. The value of an enterprise is no longer exclusively measured with profit on sales. User size, user's using experience, and user stickiness are all important indicators. One of the most powerful sources in persuasion is personal word-of-mouth. When a company's customers recommend the product to others, this reflects a high degree of loyalty [15] (see "Fig. 4").



Fig. 3. The demand-driven linear product innovation process.

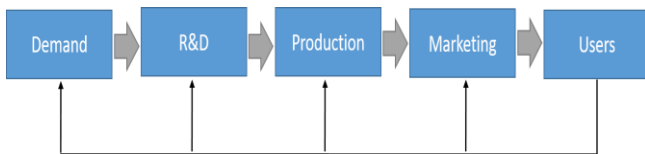


Fig. 4. The user-centered product innovation process.

B. The Modularization of Division of Labor

Modularization means that the company's main resources are gradually focused on the core business, and some non-core businesses are transferred to the outside of the company through outsourcing and other forms [16]. The core competencies of different companies are connected to each other to form an open network of external value. The value creation, exchange, and sharing of related companies are distributed throughout the network. The companies in VIECs gather around the core platform companies through formal or informal social relationship and can continuously and efficiently optimize the combined resources according to their needs. Since a VIEC is like a wooden barrel, how well it can perform depends on the shortest piece of wood [17]. A "new barrel" can be formed by optimal combination of resources. Each piece of wood of the "new barrel" is the longest. The volume maximization of the barrel thus can be achieved.

Modularity has been identified as one of the most important methods for achieving mass customization. More

specifically, studies have shown that modularity generates strategic flexibility because it enables firms to reduce costs and increase the speed of bringing them to market [18] [19].

C. Communitization

VIECs include two levels of virtual communities. The first is the virtual community formed by the core platform companies, key enterprises, supporting enterprises, and parasitic enterprises. The second is the virtual community formed around key enterprises. Generally, the key enterprises are themselves platform enterprises and will also form VIECs. We call them sub-VIECs. The virtual community formed by the core platform companies, key enterprises, supporting enterprises, and parasitic enterprises generally has a limited number of members and may have both formal and informal cooperation relationship with each other.

The cooperation of companies within TICs is linear. That is, the organizational division of labor is flow-based. The first enterprise completes a process, and then another enterprise completes another process. The division of labor in VIECs is network-based. That is, each enterprise in the eco-clusters communicates with each other directly and forms a complex division of labor and cooperation system. Therefore, VIEC is essentially community-based. The biggest feature of community-based VIEC is that, in addition to its formal system, it also uses the informal system to coordinate and cooperate. The informal system will play a complementary role. The informal system does not rely on contracts and other tools to make rigid provisions on cooperation, but personal relations, culture, customs, etc. will play complementary roles which make the partnership more flexible, efficient and lasting.

Virtual Communities formed around key enterprises will be used as platforms for interaction between companies and users. Since virtual communities can break the limits of time and location, communication can be more convenient. After joining the community, users will gain a sense of identity and belonging and can be actively involved in the design, producing and marketing processes of products. The traditional linear production process was broken. It can be said that sub-VIECs have changed the previous product-based economy and formed a user-based economy. The so-called user-based economy refers to an economy based on users' active involvement in the value-creating processes. Various activities in communities can enable consumers to gain experience that will lastingly affect their loyalty and behavior, which can bring huge economic benefits [20].

D. Winner-take-all Effect

Member companies within VIECs cluster around platform companies. Each member company plays a role in the ecosystem. Companies in VIECs can overcome geographical restrictions of TICs by gathering through the Internet. They not only have the advantages of TICs, but also have the advantage of being efficient when interacting virtually. Platform companies, such as Tencent, Alibaba, Meituan, Airbnb, and Uber, have many other companies gathering around them and have formed complete

ecosystems. Companies within VIECs have their respective resources and they can all play their roles in the clusters to improve the efficiency of the entire VIEC. In VIEC, the platform companies are the foundation of virtual aggregation. Through VIEC, the platform companies can share their resources, maximize their interests, improve their own industrial chain, and upgrade their competitiveness. Platform companies often benefit from economies of scale, operating with higher efficiency and lower average costs. Network effects are another reason that platform companies can grow quickly. When the user scale reaches a certain point, the number of users will then grow geometrically [21]. In China, top internet companies have acquired most of the users and profits and they are growing continuously. For example, Tmall occupies 53.2% of total B2C sales in China [22] and Tencent occupies 51.6% of total online gaming market in China [23].

Specifically, there are, at least, three reasons for this phenomenon in China (see "Fig. 5").

1) *Aggregation effect*: There is fierce competition among Internet companies. The survival and development of enterprises are subject to great uncertainty. Therefore, investors prefer to invest in top companies in industry so that they can avoid risks and quickly gain profits. Such a preference for investment makes it easier for top companies in the industry to obtain sufficient funds for product innovation and improving user experience. In this way there forms a virtuous cycle and an aggregation effect is achieved. Start-up companies are likely to fail in the competition because they lack sufficient resources and support. Large-scale Internet companies often benefit from external economies of scale, which can increase production efficiency and lower average costs.

From the perspective of users, the greater the scale of Internet companies, the more attractive they are to potential users. Large scale means mature technology, complete user protection system, and better using experience. Users and traffic are the key factors that can determine whether an Internet company can survive. Compared with start-up companies, large-scale Internet companies which have taken the lead are easier to gain trust of users. With trust of users, large-scale Internet companies are able to improve their services and gain even more users.

2) *Lock-in effect*: Lock-in effect means that once a user enters and is accustomed to a certain platform company, this platform company has a lock-in effect on the user [24]. The more attractive the platform companies are, the more reluctant the consumers on the Internet are to leave. Switching costs play a vital role in lock-in effect. If a user is to transfer to another platform, there will be switching costs. The research on switching costs has also been extensive [25]. There are roughly three sources of switching costs. The first is transaction costs. Transaction costs include time costs, information-searching costs, etc. The second is learning costs. The third is sunk costs, such as human capital investment and complementary asset investment. If the gained benefit is

not big enough, users will not be likely to switch to another platform. For example, when consumers are considering switching to another music service platform, they face switching costs. Changing vendors would force them to configure new music players and recreate playlists [26]. When the transfer costs are high enough to offset the benefits of the transfer, consumers will be "locked in". Even when they are faced with a potentially better music service platform, they are more likely to use the previous platform which they are familiar with.

3) *Obstacles to start-up companies*: Start-up companies with limited resources are difficult to compete with large-scale developed enterprises. Mature technology, complete user protection system, and better using experience are factors which contribute to attractiveness for users. In competition with large-scale enterprises, start-up companies will encounter many obstacles.

Internet platform companies are generally two-sided markets. The scale of users in the two-sided market has a decisive effect on the value of the companies. With two-sided network effects, the platform's value to any given user largely depends on the number of users on the network's other side. Value grows as the platform matches demand from both sides [26]. Most of the Internet platform companies in China will initially attract users with free services and even subsidies. Only in this way will they gather a large number of new users. Reaching a certain scale, they will manage to provide some services to gain profits by taking advantage of their user resources, such as provide advertising services for some other companies. Two-sided markets make it difficult for start-ups to reach an effective size from the beginning, because they need to enter both the free-side market and the profit-side market. When the number of users reaches the threshold of scale, the Internet companies can gain explosive growth of the number of users and form a virtuous circle. Only when the scale of users reaches a certain extent can they Internet companies be able to enter the profit-side market. But to reach the threshold of scale is full of challenges. Therefore, the two-sided market structure makes the development of start-up companies more difficult.

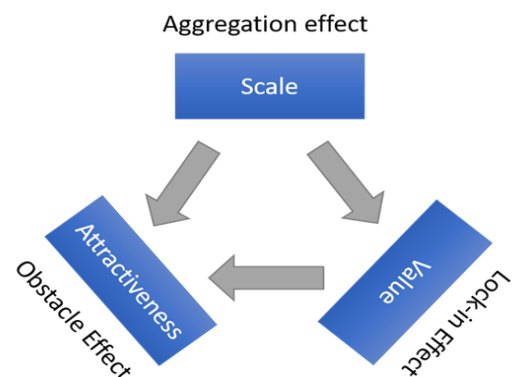


Fig. 5. The reason for winner-take-all effect.

V. CASE STUDY OF PINDUODUO IN TENCENT E-BUSINESS VIEC

A. The Formation of Tencent's Open Strategy

Founded in 1998, Tencent is one of the largest Internet integrated service providers in China and one of the Internet companies with the most service users in China. According to Tencent's 2017 financial report, the number of monthly active users of Weixin, the most popular social application in China, reached 988.6 million.

Before 2003, Tencent attempted to conduct derivative business by take advantage of its huge number of users. This caused fierce competition between Tencent and other Internet companies in China. Because of path dependence and other reasons, some derivative businesses are not so successful, such as e-commerce business, short video business, and search engine business. Path dependence refers to the fact that once an enterprise enters a certain path, it will follow the established path. This path may be inefficient or even inefficient. The subjective selection model determined by participants' cognitive ability agrees with the old basic institutional structure, resulting in the continuation of the old system in a new form in the new system [27]. The company's previous investment and its repertoire of routines (its 'history') constrain the company's future behavior [28].

In 2010, the famous "3Q Conflict" broke out between Tencent and 360 company, also a well-known Internet company in China. This conflict has prompted Tencent to break the path dependence and fully implement the platform opening strategy. Cooperating and sharing users and traffic with other professional companies, Tencent as the core platform company has formed many kinds of VIECs around it, such as E-business VIEC, online game VIEC, online travel VIEC, insurance VIEC, education VIEC, medical VIEC, etc. It is the formation of these VIECs that has made Tencent achieved great successes. In 2010 before the implementation of the platform open strategy, Tencent's market value was approximately \$42.5 billion. After the implementation of the open platform strategy in November 2017, its market value reached \$522.9 billion. It can be said that Tencent's VIECs has brought huge profits to Tencent. At the same time, it also enabled other member companies in VIECs to gain high-speed growth.

B. The Case of Pinduoduo in Tencent E-business VIEC

This paper takes Pinduoduo in Tencent E-business VIEC as an example and explores how key companies cooperate with core platform companies and how to achieve external economies of scale and reduce transaction costs through VIEC. Pinduoduo is a key member company in Tencent E-business VIEC. Since established in September 2015, Pinduoduo has formed a strategic cooperation with Tencent. In less than three years, Pinduoduo has become one of the largest social e-commerce companies in China. In December 2016, MAU (monthly active users) of Pinduoduo was about 9 million and the average monthly GMV (Gross Merchandise Volume) 2 billion dollars; in December 2017,

Pinduoduo's MAU rapidly increased to 99 million and the average monthly GMV rocketed to more than 40 billion dollars.

How can a newly-established company grow so fast? The main reasons are as follows (see "Table I").

1) *The support of Tencent's e-business VIEC plays a very important role:* Most of Pinduoduo's users come from Weixin, a very popular social mobile application in China with more than 900 million users. Different from traditional e-commerce companies, Pinduoduo relies on users' self-propaganda as main marketing means. If a user is interested in a product on Pinduoduo platform, usually he or she will send the link of the product to his friends by Weixin or put the commodity message into his Weixin's Circle. The more transactions his friends makes, the cheaper the price of the product will be. In this way, Pinduoduo not only obtains massive users at relatively low prices, but also gains a lot of deals as well. Trust is very important in making deals. Trust rules out undesirable, yet possible and opportunistic behavior on the part of others [29]. By entering the VIEC, Pinduoduo can easily gain users' trust resulting from transfer of trust of Weixin and save transaction costs. Logistics, payment and other member companies as modules in the VIEC can help Pinduoduo focus on its main business.

Social e-commerce can effectively stimulate potential consumer's demand through "social" methods. The marketing of products mainly lies in the user's active word-of-mouth communication and interpersonal diffusion. More importantly, the recommendation of products from acquaintances or friends often has a much higher degree of objectivity and credibility and can stimulate consumer's further demand.

Pinduoduo divides consumers into different groups and consumers with similar preferences will come together to form small groups. These small groups will recommend products to each other. The recommended products will have more targeted consumers and the transaction rate will increase significantly. This socialized transaction process can help users remove irrelevant and redundant information of products and improve consumers' buying experience by interacting with friends.

TABLE I. THE SHOPPING PATH OF USERS AND THE MANAGING PATH OF OPERATORS OF PINDUODUO

	Account System	Sharing System	Payment System	Logistics System	Review System	Community System
<i>Users of Pinduoduo</i>	Use Weixin or other third party account to login	Users share products' link with friends or acquaintances by Weixin → Friends or acquaintances buy the shared products → Users receive a discount for the shared products	Use Wexin payment system to pay Use other third party's payment system to pay	Inquire Real-time logistics information Remind/urge delivery of bought products	Review products or services Refer to other users' reviews to make purchase decisions	Share shopping experience Interact with other users Obtain product information
<i>Operators of Pinduoduo</i>	Manage active users Manage inactive users	Manage product Information Manage product recommendation Mange users' shared information	Manage orders Manage refunds	Recommend third-party logistics service Manage delayed shipment Manage improper delivery	Formulate rules of review Review management	Interact with users Recommend products to community users by big data

2) *Aggregated personalized needs of users enable customization of mass production:* The concept of sharing and socializing are the core of Pinduoduo’s business model. When a user likes a product on the platform, he or she will send a link of the product to his friends or relatives via Weixin. When his or her friends or relatives are willing to buy the product, the product will be available at a lower price. That is, the more people who want to buy it, the lower price it will be.

The mismatch and misalignment between supply and demand are two of the major problems in economic structure of China. Usually when the demand side changes significantly, the adjustment of the supply side shows obvious hysteresis. In other words, the biggest obstacle in the current economy of China is that communication between supply side and demand side is not evenly distorted. Social e-commerce has an advantage in the acquisition and integration of demand-oriented information.

By increasing external economies of scale and reducing transaction costs, merchants can sell their products at a relatively low price on the platform. On the other hand, this can further increase the attractiveness of the platform. Users can induce other users to purchase by sharing products’ links to the community. Aggregating demand can lead to lower prices of products which will attract more consumers. The low-price strategy is surely Pinduoduo’s another trump card which utilizes users’ loss aversion psychology. When a user sees an ideal product at a low price shared by a friend, he or she will feel a loss when not buying. Loss aversion refers to people's tendency to prefer avoiding losses to acquiring equivalent gains [[30][0]. Due to the loss aversion psychology, users are likely to purchase a product if he or she feels that it is worthwhile and at a low price to averse a loss. At present, a great many consumers in China are price sensitive. The

low-price strategy can work especially in rural areas and economically underdeveloped cities.

3) *Paying attention to building a user community:* In China, the “business is business” rule doesn’t work — it is too cold. You have to be professional and build up a “warm” relationship with others at the same time [31]. Pinduoduo pays a lot attention to building a user community in order to strengthen the relationship with users. The user community can benefit both Pinduoduo and users. Users can communicate with each other and can receive official information about products in the community. Through the community, users can give feedback on products and the community operator can answer questions about products from users. In this process, users are likely to become fans of Pinduoduo.

Also, by analyzing information given by users in the user community, Pinduoduo can further understand the needs of users and perform further product innovation. Users have long been acknowledged as important contributors to the market success of product innovation. Users constantly encounter needs (problems) that have usually not yet been satisfied (solved) — In order to solve the problems arising from the use and improvement of products, it is necessary to rely on the users of the product [32]. Enterprises should work closely with users to understand their needs and develop product innovations alongside them [33].

VI. CONCLUSION

A. Conclusion

This paper innovatively introduces the concept of VIEC and the Empowerment Model. VIEC is a new form of development of TICs in the Internet age. In VIECs,

Consumers actively participate in production and other value-creation processes and can benefit from the scale economies which can satisfy their personalized needs efficiently. In the process, by connecting with consumers directly, manufacturers can also benefit from gathering information of users' needs in advance which enables the reversed mass production. The supply-to-production model ensures the balance between supply and demand, helping to reduce the amount of stock and reduce production costs, as the case of Pinduoduo in the Tencent E-business VIEC mentioned above.

The Internet has made the boundaries of companies unclear and it is difficult to distinguish between internal and external environments. Every company acts as a module in the VIECs. The modularization of division of labors can make companies gain extra strengths as other member companies in the VIEC which are the best in their branch areas cooperate with them and they can focus on their main services.

Communitization of users makes relations between the company and the consumer transferring from one-way value transmission to bi-directional value transmission. The sales volume of a product depends on the degree of stability of the relationship between users or companies in the communities, no longer subjecting to a passive product lifecycle. In VIECs, the value-creating processes are user-centered, not product-centered. Communities are platforms where users can participate in the whole processes of value-creating.

B. Implications

Public policy makers should support the development of platform companies and promote the transformation of TICs to VIECs. Platform companies are the key to the formation and development of VIECs. Only by vigorously developing platform companies can we gather other member companies and eventually form complete industrial ecological chains and realize the sustainable development of the clusters.

As for TICs, they should evolve with the transformation of business models. The emergence and swift expansion of the Internet and the rapid decline in communication costs has allowed the development of new models of business to create and deliver value. [34] Because of geographical restrictions, TICs are not able to efficiently satisfy customers' personalized needs. Traditional linear value-creation processes should be changed into user-centered processes which allow users to actively participate in the design, production, and sales of products. By virtual collaboration through Internet, companies in TICs should speed up the implementation of the modular division of labor. Companies in VIECs can make full use of the virtual collaboration, sharing resources with one another in order to achieve external economies of scale and reduce transaction costs.

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