Modularity in Platform Competition

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Abstract—**This paper explores how modularity logic facilitates platform competition to approach competitive advantages, in particular with context of a business ecosystem rather than a firm. The research adopts a case study approach. Data are collected through semi-structured interviews, and secondary resources including company annual reports, archives, and websites, and industry reports. The results indicated that product/service modularity should be aligned with business ecosystem modularity to facilitate network effects in platform competition. This research extends modularity research from the firm level to a business ecosystem context, and develops a two-layer modular architecture of platform competition in the business ecosystem.**

Keywords—modularity; platform; business ecosystem

I. INTRODUCTION

Platform has become one of the essential factors contributing to the success of many industries [1], particularly high-tech industries, and winning platform competition brings companies more competitive advantages. The platform can be regarded as comprising the building blocks (which can be products, services, or technologies) acting as the foundation on which partners can develop complementary products, services, and technologies [2]. A successful platform strategy enables the effective development not only of new products but also new services, and it also shapes business models and even transforms entire industries [3]. Moreover, platform competition emphasizes the importance of the network effects [4]-[5], which prescribe rapid expansion of a network consisted with players including both platform users and complementary services (applications) providers to capture the entire markets. The network of platform owners, users and those complementors (who provide the complementary products, services, and technologies) is called a business ecosystem [6]. The challenge to companies is how they can achieve competitive advantages via platform competition in the context of a business ecosystem.

On one hand, product/service, and their variety and quality based on the platform, are the key reasons why users will stick with a particular platform, and this correspondingly increases its value. Hence, one critical success factor of platform competition is offering a higher variety of product/service to attract more users and complementors to join the platform, it could be exponentially increasing of them as indicated by the network effects [4]. It is well known that modularity contributes much to product variety [7]-[9], and it has been highlighted that service modularity via a platform approach is also helpful to the development and delivery of new services in a cost-effective and more flexible way [10]-[11]. This research aims to understand how modularity is applied into platform competition and how it influences network effects.

On the other hand, the business ecosystem consists of the platform owner (which is normally regarded as the focal company) and all partners and users [6]. Those partners who provide complementary applications/services are also defined as complementors [4]. Following the network effects, with more users and complementors adopting the platform, it will create more value to the platform owner, and also to the platform users and complementors. Obviously, developing a robust platform architecture brings competitive advantages to all stakeholders in the business ecosystem. With an increasing number of users and complementors, the business ecosystem becomes a much more complex network. As a result, the traditional competition among firms has transferred to a competition among business ecosystems [12]. From an organizational design theory, an individual corporation is not sufficient to act as a primary unit of analysis [13]-[14]. Organization designers should consider the appropriate distribution of property rights, people, and activities among those players in the ecosystem, but in a way benefiting to both those players and also the design organization itself [13]. In order to reach the objectives of platform competition, it is necessary to have a better understanding of the operations of a business ecosystem. While modular thinking is very helpful to understand a complex system and organization [15], this research adopts modularity to investigate the organizational structure (actors and their roles) of a business ecosystem, and to explore how modularity at organization level contributes to network effects in platform competition.

Modularity has been mentioned and emphasized in the original work on business ecosystems and also in subsequent research [4,6,12,16]. However, there has been limited in-depth exploration of how modularity contributes to the success of platform competition within the context of a business ecosystem. Hence, research question in this paper is defined as, how does modularity contribute to platform competition in a business ecosystem context?

This research contributes to the understanding of modularity in platform competition, and it brings insights to practitioners as well as theoretical contributions to operations management in services.

II. METHODOLOGY

This research adopted case study method in order to reflect the contemporary and complex nature of the defined research questions [17]-[18]. In order to enhance the research results and produce robust conclusions, multiple case studies were conducted [19]. Three cases were selected according to criteria following the conceptual research framework development, which means that each individual case should be successful in platform competition, with a range of products/services that have been built around the platform, and where a business ecosystem has been nurtured and is now running very healthily.

Data collection: In this research, data were mainly collected via semi-structured interviews to gain managerial insights from the interviewed managers [20]. Only the platform owner company in the business ecosystem was involved in the data collection. In each case, two middle-level managers and one manager at the top level were interviewed, each for 2-3 hours. However, in order to ensure data validity [17], multiple sources of evidence were used to meet the data quality criteria. The sources used include company annual reports, secondary documentation, archival records, and field visits. All data collected were cross-verified with each other to ensure the accuracy of the data.

Data analysis: The data collected were analyzed through a pattern-matching strategy to test whether the empirical data match the pre-defined elements in the conceptual research framework [17]. This logic also ensured the construct validity of this research [17, 21].

III. RESULTS

The case study findings lead to the discussion of five research propositions.

A. Modular Architecture of A Business Ecosystem

The research results show that a business ecosystem is a complex business community consisting with a huge number of players and interactions. Regarding platform competition, there is always a platform owner (such as Tencent, Xiaoju Keji, and JD.com) in the business ecosystem. The platform owners are a keystone [16, 22] player within the ecosystem, and the most important thing for them is developing an innovative platform for the co-evolution of all partners in the complex business ecosystem. With its complex nature, operational strategies and appropriate approaches and mechanisms play essential role in nurturing and evolving the business ecosystem.

Following the modularity theory, we proposed that there are two layers in the modular architecture of a business ecosystem, including product/service and organization. The organization layer presents the organizational structure of a complex business ecosystem with a variety of players (organizational modules), including users, suppliers, partners, complementors, and platform owner. The product/service layer presents the various service offerings (service modules) provided via the platform. The services could be developed by the platform owner, complementors, or other partners. Both services and the business ecosystem can be designed and organized with a modular logic, which on the one hand could offer sufficient service variety to customers and on the other could also mitigate the uncertainties in the system.

These results lead to the first research proposition:

P1: A business ecosystem implies a modular architecture with two layers, including product/services and organization. The modular architecture of a business ecosystem is a mapping of the relationship between product/service layer and organization layer.

B. Three Types of Modules at Different Layers in A Business Ecosystem

From the perspective of the modularity theory, those modules at different layers in the modular architecture normally can be considered as the physical elements in the business ecosystem. This is very similar like those modular components existed in product architecture and represented specific function of the product. The results of this research show that those modules could be categorized into three types of functional modules, and each reflects relevant role and function at different layers in the architecture of a business ecosystem.

These three types of module are defined as evolutional module, developmental module, and fundamental module in this research. Different types of modules represent different roles and functions within the architecture of service and organization. For example, in the business ecosystem of Wechat, if talking about the organization layer, the evolutional module should be Tencent, who always leading the evolution of the business ecosystem via the platform innovation, or the initiatives of new ideas for future development. The developmental module is normally those complementors, for example DiDi Dache, who creating new services or apps. Those developmental modules usually act the importance role to enhance and facilitate the evolution of a business ecosystem. Reusability is regarded as an important feature of the developmental module. Examples like hardware and accessories suppliers, mobile network operators, and OEMs (original equipment manufacturers), are normally providing fundamental services to the entire business ecosystem aiming to ensure its continuity of the ecosystem.

In the service layer, the evolution module is the one that could lead to opening up new businesses and starting a new business ecosystem. For example, the friend-adding service originally was part of the QQ platform. However, this service was then further developed into a new service like "Shake" or "People Nearby" by using location-based technologies. This led to the creation of a new app, WeChat, with those new service features, a new platform, and also a new business ecosystem based on the WeChat platform. The evolutional module is extremely important when new technology is introduced into the market, acting in the role of changing the whole industry. In terms of the developmental module, those service modules are developed around the evolutional service module, and also act to support and facilitate the evolutional service module. Fundamental modules, like the payment service module in the WeChat platform, have fundamental support functions to other services such as online shopping and ticket booking.

The characteristics of these three types of module are summarized in Fig. 1. The research results lead to another research proposition here:

P2: At different layers, there are three types of module, including the fundamental module, developmental module, and evolutional module. Different types of module have different function roles in the business ecosystem.
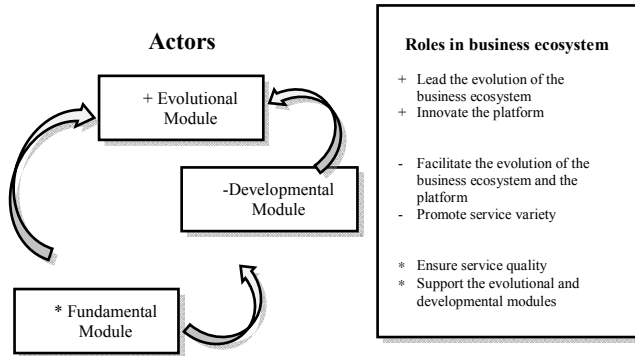

Fig.1.   Three types of module in a business ecosystem.

C. Align Service Modularity with Organization Modularity

From the research results, it is obvious that services are designed either by the platform owner or complementors, which means a clear inter-relationship between service module and organization module. This reflection in the modular architecture shows the complexity of the business ecosystem, and also different platform strategies.

For one thing, the complexity of the business ecosystem, a reflection of the inter-relationship between service module and organization module, could have many forms: one-to-one, one-to-many, many-to-one, and many-to-many. One-to-one means one company delivering one service in the business ecosystem: for example, in the WeChat business ecosystem, only DiDi Dache provides a taxi-calling service to users on that platform. One-to-many means one company actually delivers several services: for instance, JD.com not only provides online shopping services, but also logistics services. Many-to-one refers to a situation like the many restaurants that have seat-booking services for users on the WeChat platform. Many-to-many means that different merchants offer different services to users on the platform.

Another aspect is that different platforms could have different platform strategies, namely open and closed platform strategies (as presented in Fig. 2). This leads to different choices of forms of relationship in the modular architecture, as discussed above.

With a closed platform strategy, the platform owner normally develops various services by itself, especially evolutional services. For example, the platform strategy of JD.com is more like a closed strategy. JD.com regards itself as a technology-driven company, so it has invested a large amount in developing its e-commerce platform to enhance its online shopping services. Meanwhile, different business units have developed a range of services around this e-commerce

platform. However, there is almost no complementor in the business ecosystem or complementary services developed by other partners to this platform, since the platform is open neither to other partners nor to developers. Hence in JD.com's business ecosystem, there are more one-to-one and one-to-many forms reflecting the relationships between service and organization layers. For an open platform strategy like WeChat (although it is not a fully open platform), the platform owner actually welcomes several complementors being involved in its platform, such as DiDi Dache was involved to provide taxi services. As a result, there are several different forms of reflections between service and organization layers.
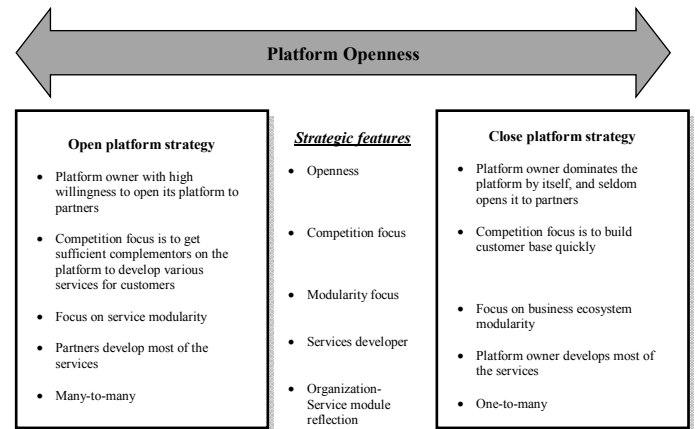

Fig.2.   Different platform strategies in a business ecosystem.

Based on these research results, we emphasize the alignment between services and organization layers and develop the following research proposition:

P3: Service modularity should align with business ecosystem modularity (organizational modularity) to ensure the efficiency of platform competition. Different platforms will lead to different forms of the reflection between service and organization layers in the modular architecture of the business ecosystem.

D. Product/Service Modularity and Platform Competition

When considering platform competition, the results highlight the importance of service modularity in the business ecosystem. A business ecosystem can be treated as a two-sided market with users and partners/ complementors. A successful platform owner always tries hard to bring users and complementor on board the platform. With more users and partners/complementors, the value of the platform will increase and it will correspondingly attract more users and partner/ complementors, which are network effects.

This kind of effort will be largely decided by the platform strategy (open or closed) adopted by the platform owner. An open platform strategy really pulls both sides on board, but there is much more focus on the user side in a closed platform strategy. For example, JD.com and DiDi Dache are relatively closed platforms, and the platform strategy for them is to accumulate users quickly around their platform. That is the reason why they all undertake lots of promotions to attract customers at a very early stage of their business.

In order to attract users and complementors, high product/service variety is needed to meet their demands and satisfy their expectations. One strategy to achieve this is to adopt modularity in product/service design and organization design (as described in Fig. 3). In a business ecosystem, the platform (evolutional module), product/services (key and support product/service), and sellers/buyers can all be categories in three types of module, as indicated in research proposition P2. By increasing the product/service variety via modularity logic, more customers will be attracted to using those services and binding themselves to the platform. This obviously will increase the value of the platform, and then it will attract more customers and more complementors to develop products/services to satisfy customers. The results in this research lead to the conclusion that modularity can facilitate network effects in a two-sided market.
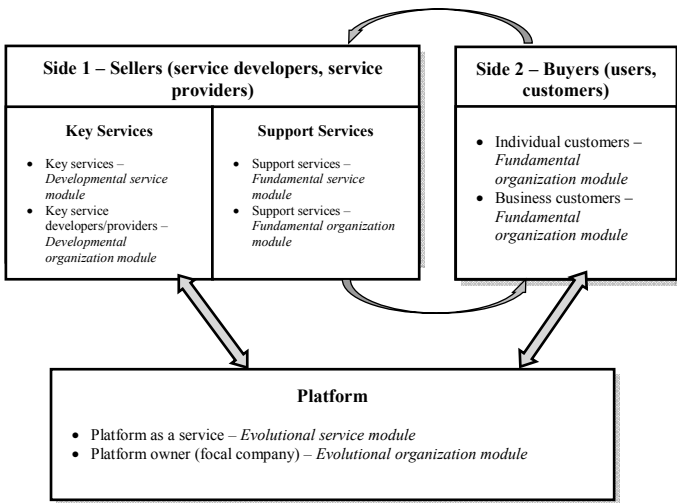

Fig.3.   Service modularity in a two-sided market.

Overall, the results suggest that established product modularity thinking can be applied to services. This evidence supports our fourth research proposition:

P4: Product/Service modularity and organization modularity will facilitate the network effects within platform competition. Different platform strategies will lead to different focuses of the platform owner on the two-sided market.

E. Nurturing the Business Ecosystem with Modular Logic

A preliminary research result of our study is that modular logic not only works in the product/service area, but in the organization level, namely at the business ecosystem level, rather than only at the firm level.

The results show that when companies adopt a platform strategy to compete and try to gain competitive advantages, they will put much effort into promoting their platforms to attract users and partners/complementors. On the one hand, this inspires the development of new products/services around the platform, which leads to higher product/service variety in the business ecosystem (see Fig. 4). On the other, with an increasing number of complementors and other partners, it increases the diversity of the organization modules in a business ecosystem. Meanwhile, with more products/services

offered and more complementors involved, this means that it also facilitates the network effects that platform competition pursues.
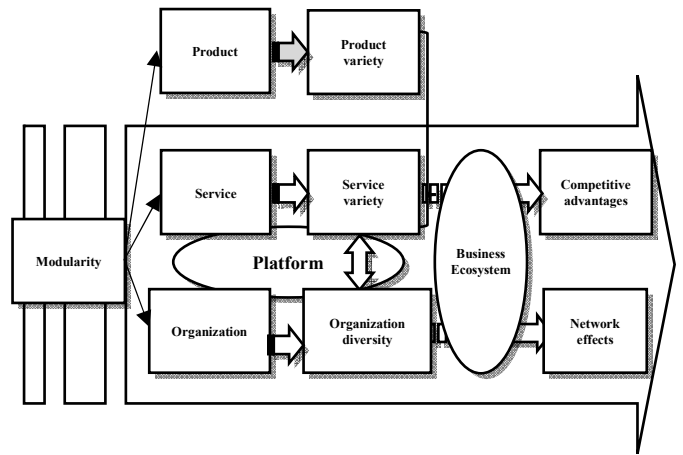

Fig.4.   Nurturing a business ecosystem with modular logic.

For the design of a product/service, with the implementation of the modular logic in the process of product/service development and design, customer demand is believed can be satisfied by the high variety of product/service. Applying modular logic into the business ecosystem means not only apply it to organization design, but also to product/service design, to some extent also to the technology deign, process design. More importantly, also the platform design.

From this perspective, with the application of modular logic in the business ecosystem, it will reduce the complexity of the network structure. Furthermore, such implementation becomes highly efficient to respond uncertainties happened in the real-life business world. Those uncertainties include the ones related with technology, application, and market [12].

Overall, we conclude here that companies should adopt modular logic from the beginning in service design and organization design, especially in nurturing a new business ecosystem.

P5: Nurturing a business ecosystem with the modular logic might decrease the structure complexity, and it could mitigate the uncertainties within an environment of dynamic economics.

IV. CONCLUSION

Two layers have been clarified for a modular architecture of a business ecosystem, and those modules at different layers have been categorized into three groups. The research results have extended the current research on modularity to the level of business ecosystem. Moreover, the research results advance the understandings of business ecosystem on its structural elements.

A. Theoretical Implications

This research is believed to contribute to the operations management literature by extending the previous established product modularity thinking into the emerging topics of platform competition, and in particular by considering all these topics within the context of a business ecosystem, which is beyond the traditional company boundary. In this way, we

contribute to the further development of the school of modularity and provide insights for academic and practitioners on how both product/service modularity and business ecosystem modularity (organizational modularity) are contributing to platform competition and network effects.

This research has addressed the architecture of a business ecosystem with the modular logic. Three propositions have been developed which could be used as future research directions. With the complex nature of a business ecosystem and its difficulty of identifying its boundary, it is important to deconstruct the business ecosystem to capture the in-depth implications of designing and managing the business ecosystem. As a result, this research has proposed a modular architecture with two layers, including product/service and organization.

In this research, we have realized that previous researches put more focuses on single level analysis rather than multiple levels. Reference [23] proposed a network structure to present a business ecosystem with the introduction of the connections among supplier, core company, customers, and complementors. However, systematic perspective is still very limited in current research, which is not enough to capture the complex nature within a business ecosystem. Current research mainly focused on the organizational architecture, however, it failed to address the product and service layers, most importantly the interactions among those layers. Obviously, it is very critical to conduct multiple-level analysis when conducting research at the business ecosystem level.

In addition to the multiple-level analyses, we classified three types of module, which apply at each level, and this will comprehensively reflect various actors and activities at each individual layer in the architecture of a business ecosystem.

B. Practical Implications

This research brings several managerial implications, with suggestions for companies aiming to pursue competitive advantages through platform competition regarding how they can approach this objective in a manner that is consistent with the established modular logic, which has broadly applied in the product area.

Moreover, the study suggests to managers how different types of service module can become one of the sources for competitive advantages in platform competition within the context of a business ecosystem. We also suggest that service modularity should align with business ecosystem modularity (organizational modularity) to attain competitive advantages for all partners and customer in the entire business ecosystem.

Furthermore, this research provides insights to managers with suggestions of using both service-dominant logic and modular logic to nurture the business ecosystem, and to facilitate network effects in platform competition.

C. Limitations and Directions for Future research

A limitation of this work stems from the single case study. Historical data analysis provides more insight into when and how a business ecosystem evolves to reach success; however, multiple case studies can provide more comparative findings to make the research results more robust. Moreover, this study did not conduct quantitative analysis, in particular on network effects and performance measurement, so quantitative research may be helpful to develop and test more specific research propositions.

As a multiple-level analysis tool, the proposed architecture framework will be helpful for future research on business ecosystem. Moreover, the developed propositions should be verified and refined with empirical case studies in future research.

For future research, it is necessary to link different layer analyses and in particular to explore how modules at each layer operated and interacted. Future research also could test the results of this study to determine whether different industry backgrounds would have different results.

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