THE STUDY OF ENTERPRISE IMPORTS ON BUSINESS ECOSYSTEM ASSESSMENT MODEL

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ABSTRACT

It has been decades since the concept of Business Ecosystem appeared. The implications of the concept have experienced some changes due to the development of industrial environments, which is caused by the advancement in technological applications, such as the Internet, cloud computing, big data, mobile and wearable devices, and industrial intelligence. In this context, the evaluation model for a business ecosystem needs adjustment. This study aims to establish a systematic model for the evaluation of a business ecosystem in the current industrial environment. This study explores small- and medium-sized enterprises (SMEs) with fuzzy Delphi (FDelphi) and fuzzy analytic hierarchy process (FAHP) as its research methods. This study divides the life cycle of the business ecosystem into four stages, namely birth, expansion, leadership, and self-renewal or death. It is hoped that this evaluation model can be useful to enterprises when they assess and utilize the business ecosystem.

Keywords: Ecosystem, Enterprise Imports, Business, Small- And Medium-Sized Enterprises.

INTRODUCTION

Previous studies on organizational business strategy and inter-organizational competitive strategy mainly focused on the positioning theory and resource-based theory using organizations' own competitive advantage as their research basis. Iansiti & Levien (2004a; 2004b) explored the source of organizational competitive advantages and the position of the overall business ecosystem in the organization with the concept of business ecosystem, which serve as the basis for organizational business and competitive strategies (Buckley, 1985).

The concept of Business Ecosystem stems from the natural ecosystem in Biology. It was first proposed by Moore & Baldwin (1993) in the Harvard Business Review. Moore (1993) pointed out that many economic activities today do not involve a single industry but in multiple industries. Consequently, it is suggested that the concept of industry should be replaced by business ecosystem to analyze corporate strategies (Abdullah & Zulkifli, 2015). The concept Business Ecosystem proposed by Moore covers a wide range of factors that influence the business ecosystem, including enterprises, customers, suppliers, major producers, competitors, and other stakeholders. Different factors have different advantages and disadvantages, so there are dominant keystone species in a business ecosystem. Moore (1993; 1996) also proposed the concept of Life Cycle in a business ecosystem in four stages, namely Birth, Expansion,

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Leadership, and Self-renewal or Death, and explained the cooperation and competitive challenges at each stage (Kahraman, 2003).

The multiple ecosystems discussed in the business ecosystem are integrated with different industries and the ecosystem is formed based on competitive and cooperative activities between various organizations. This is a symbiotic business infrastructure between the organizations. Before this, the strategy theory mostly relied on a fixed industrial structure and a single organization within a given industry as the basis for discussion and analyzed its internal and external environments as the main means to obtain a competitive strategy. However, in recent years, the Internet has developed rapidly. In this context, organizations are interconnected through the Internet and have more frequent interactions. Industries are linked by the Internet to have more interactions, for which the concept of Business Ecosystem draws more attention (Kuo et al., 2008).

The viewpoint on the Business Ecosystem proposed by Moore (1993; 1996), Iansiti, & Levien (2004a; 2004b) describes the ecosystem of the Internet of Things (IoT) platform. At present, there has been a discussion on the IoT business ecosystem, mostly on how to develop business models and cooperate among manufacturers. Discussions focus on a single-application ecosystem, such as the Internet of Vehicles (IoV), business models for smart homes and ecosystems, which have not yet been tackled in the life cycle of business ecosystems (Bejari et al., 2017).

LITERATURE REVIEW

Development Stages of Business Ecosystems

Kandiah & Gossain (1998) discussed the impact of the Internet on contemporary economic activities with the concept of Business Ecosystem proposed by Moore (1993; 1996). The increasingly closer and constantly changing relationship of companies with their customers, partners, and suppliers reduces the boundaries between them. (Kandiah & Gossain, 1998) took Swedish homeware retailer IKEA as an example to point out that organizations can provide a variety of services through a single brand by collaborating with their organizations across the roles of competitors and complementor. Through the established business ecosystem, IKEA created new value for different organizations within the system, suppliers, and customers. However, Kandiah & Gossain (1998) only analyzed manufacturers such as IKEA and paid little attention to business strategies of other organizations within this business ecosystem (Jianweia, 2011).

Iansiti & Levien (2004a; 2004b) proposed that a business ecosystem is a group of interconnected companies that create values in a concerted manner and share values with each other. Moore (1993; 1996), Kandiah & Gossain (1998) discussed a business ecosystem that consists of companies, customers, suppliers, major producers, competitors, and other stakeholders. Unlike the research of Moore (1993; 1996); Kandiah & Gossain (1998), Iansiti & Levien (2004a; 2004b) focused on "*businesses that share value*" and the relationship between organizations in a business ecosystem. To discuss the relationship between manufacturers within the business ecosystem in the IoT platform more clearly, this study adopts the definition of Business Ecosystem proposed by Iansiti & Levien (2006; 2004b).

Iansiti & Levien (2004a) also borrowed the concept of a business ecosystem from biology, proposing that a business ecosystem is composed of participants from different fields

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who share a common fate. In this aspect, whether a business ecosystem is healthy or not is of great importance; once the business ecosystem collapses, all participants are not able to survive. (Moore, 1993; Nelly, 1998) proposed the concept of Business Ecosystem Life Cycle (BELC) which divides the life of the business ecosystem into four stages, namely birth, expansion, leadership, and self-renewal or death. Managers face different managerial problems at each stage, and the reciprocal effect between companies under competition, cooperation, and complex strategies remains unchanged (Li et al., 2016).

1. Birth: This phase focuses on creating the value of a new product or service that consumers want and finding out the best model to help consumers meet that need. Ecosystem integrators bring together suppliers from all sectors to the ecosystem, which not only helps create new value but also prevents the supplier from helping other potential ecosystem integrators.
2. Expansion: the ecosystem faces competition for market share at this stage; it competes for market share with other ecosystems in the same market. To this end, companies spend a great amount of energy in marketing and sales, manage large-scale production and distribution, and gradually expel incomplete ecosystems. Other supply chains are integrated through system members to stabilize the entire ecosystem.
3. Leadership: With the expansion of ecosystems, ecosystem integrators need to guide system members through investment directions and technology standards. Innovation is an important factor in strengthening the added value of ecosystems. The guidance of ecosystem integrators helps the ecosystem maintain an appropriate profit. The bargaining power of suppliers is also enhanced at this stage, especially for key component manufacturers. Ecosystem integrators should ensure that a single product has multiple supply chains to guarantee the stability of production and supply. Lastly, the bargaining power is strengthened by having a good command of key activities.
4. Self-Renewal or Death: In the face of environmental changes, the emergence of new ecosystems poses a threat to existing ecosystems and even destroys them. Ecosystem integrators need to beware of new trends and incorporate new innovative elements into the ecosystem. When the appropriate ecosystem is mature, ecosystem integrators need to assign a project team to create a new ecosystem that promotes the transformation of the ecosystem and seek a balance between stability and transformation.

At birth, the first phase, entrepreneurs focus on customer needs, creating value for new products or services, and finding out the best way to deliver the value. A good entrepreneur is a person who best defines and delivers customer value in the short term (Pilinkiene & Maciulis, 2014). In addition, entrepreneurs have a great need for general cooperation during the start-up period. In this period, those who can provide a package of values to customers with the entrepreneurs will make an appearance, leading the entire ecological alliance to make constant improvements (Lin, 2005).

At the second phase, expansion, the business ecosystem continues to expand in order to occupy vast new territories. The business ecosystem at this period has three characteristics: (1) competing with other ecosystems to protect existing markets, (2) stimulating customers' demand for products or services provided, and (3) satisfying customers' needs with sufficient supply. The winning ecosystem has a large number of business ideas that customers recognize and the possibility to extend the business ideas to the entire market (Ishikawa, 1993).

The leadership phase is a time when enterprises within a business ecosystem compete for a dominant position. Through expansion, members within the ecosystem take over production and operating activities of the closest members in the value chain, thus providing customers with a variety of value elements. The leading company will provide guidance on the investment direction and technical standards of the ecosystem, ensuring that it has a solid supplier and has bargaining power by controlling the core value elements within the system (Mitleton, 2003).

At the fourth phase, self-renewal or death, members pay close attention to new trends that may subvert the entire ecosystem, build new management teams and even new ecosystems when

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necessary, or balance the relationship between stability and transformation by adopting new innovations constantly (Nezarat, 2015).

Research on Evaluation Indicators for a Business Ecosystem

The purpose of enterprise innovation is to enhance its external competitive position and strengthen its internal capabilities through product or process innovation. However, innovation is not the ultimate goal; enterprises aim to achieve good performance through innovation (growth and profit). Innovation is not the sole determinant of corporate performance; innovation is a necessary condition but not a sufficient basis for corporate performance (Nelly, 1998). When the relationship between innovation and company performance is being measured, a production function is adopted in most cases. The commonly used independent variables include the number of employees, hardware assets, and innovation (like R&D expenditure and the number of patents). The dependent variables are the sales amount or added value (Mairesse & Mohnen, 2001). Another research perspective approaches the relationship between innovation input/output and company performance (positive and negative, intensity). It is generally believed that there is a positive relationship between innovation and performance. Based on the results of previous research, there is a significant relationship between innovation and performance (Geroski, 1989; Crépon et al., 1998).

Iansiti & Levien (2004a) borrowed Moore's basic view on ecosystems to analogize business ecosystems, defining a business ecosystem as a group of loosely connected system participants who share fate, experience co-evolution, and create and share value. In addition to the business ecology and developmental stages put forward by Iansiti & Levien (2004a) also proposed a sound business ecosystem; like a biological ecosystem, a sound business ecosystem has three key evaluation indicators, namely productivity, robustness, and niche creation.

In terms of productivity, business is equivalent to network capabilities of technology and other reform tools being transformed into low-cost and new products. The return of a company's capital concentrates on industrial software, bioengineering, and network services. In the past decades, Iansiti and Levien found that these three different ecosystems have significant productivity. The return on capital of the software industry exceeds 10% while the return on capital of the bioengineering is about -5% (negative growth). It is predicted that Internet service companies have a return on capital of nearly -40% (negative growth). The return on capital of the business ecosystem for software and bioengineering has not changed year after year. In this context, the Internet service ecosystem witnessed a decline. Taking Yahoo as an example, it began to decline between 1996 and 1997 because it charged a fee on the search of the company's website. Evaluating the health of an ecosystem beforehand is beneficial to the company (Van Laarhoven & Pedrycz, 1983).

Moreover, productivity is an economic term that refers to the performance and efficiency of the process of transforming raw materials into products, which is about the output per unit of input. The productivity increases due to the improvement in capital or labor efficiency. Often, it is impossible to separate capital productivity from labor productivity. In general, the concept of productivity is limited to labor productivity. Productivity, which is about the effective use of innovation and resources to increase the added value of products and services, is the output of each unit of labor input in a certain period. The production of more products with fewer resources means an increase in productivity. Nowadays, working hours for humans are shorter than before but the work efficiency is improved due to the use of high technology. That is why

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humans today have better lives than before. The increase in productivity is the real source of economic growth, bringing in long-term economic benefits and improvements in the standard of living (Pierce, 1988; Guinet, 2001).

Robustness means that the ecology provides dependent organisms with lasting benefits amidst the changes in the environment. The same business ecosystem should be able to avoid collapse when meeting unexpected technological changes (Prahalad & Ramaswamy, 2004). The benefits are obvious. The external shocks it faces can be buffered when the company is part of a predictable and sound business ecosystem and has good relationships with the business ecosystem and its members.

In biology, robustness means that the system retains its characteristic behavior in the event of perturbations or uncertainties (Wieland & Wallenburg, 2012). Robustness in the small refers to the situation wherein perturbations are small in magnitude but the "*small*" magnitude hypothesis can be difficult to verify because "small" or "large" depends on the specific problem. Conversely, the robustness in the large problem is the case wherein no assumptions about the magnitude of perturbations for it can either be small or large (Alippi, 2014). Moreover, resistance and avoidance are the two dimensions of robustness (Durach & Machuca, 2015).

As for niche creation, productivity and robustness do not cover all the characteristics of a sound business ecosystem. The literature on ecology points out that the diversity presented in these systems is also important, for it supports the diversity of species. This also applies to the business ecosystem, which is recommended to have the ability to absorb external shocks and potential productivity reforms (Iansiti & Levien, 2004a) (Kou et al., 2010). In the ecosystem, it is important to improve the ability to create meaning and diversity along with the addition of new functions, namely the ability to create new niches.

The business ecosystem that Iansiti & Levien (2004b) depicted contains many relatively small subsystems. All participants in such small sub-systems are niche marketers in comparison to key stone in the business ecosystem. However, the subsystem has its own key person sometimes. Compared with other participants in the subsystem, these key stone have a dominant position. In the overall business ecosystem of software, they still play the role of niche marketers and have a relatively close relationship with key stone. In other words, most manufacturers participate in multiple business ecosystems at the same time and play different roles in different subsystems. This view has been verified by (Iyer et al., 2006).

In addition, Dedehayir et al. (2018) also proposed that the promotion of new technologies, cooperation, and co-creation of members can improve productivity and competitiveness. Choi et al. (2018) explained seven indicators linked to ecosystems from the perspective of robustness, productivity, and diversity. The risk of business ecosystems can be reduced through mass outsourcing to maximize robustness (Kannangara & Uguccioni, 2013). Continuity, adaptability, innovation, and stability are the key to maintaining the health of an ecosystem (Lappi et al., 2017). Vargo et al. (2018) explained that the innovation process is driven by the integration, exchange, and application of resources through multiple members.

Moreover, it can be found that niche marketers interact with key persons. The key persons obtain resources in a broad sense, including technology, partner, reputation, and knowledge. Niche marketers have different ways of using these four resources. First, niche marketers use the technology of the key person to develop various software products. Second, niche marketers use key channel partners to develop customers. Third, niche marketers take advantage of the reputation of key persons to increase the trust of distributors and customers. Fourth, niche marketers utilize the knowledge of key persons through learning, including

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technical knowledge and managerial knowledge. Having learned two kinds of knowledge, the technical and managerial skills of the niche marketers are improved (Kou et al., 2010).

Today, an increasing number of companies realized that regarding a collaborative platform as a business enabler allows corporate groups to increase their quotations and competitiveness, for which they are motivated to stick to the platform. Consequently, the concept of Business Ecosystem has become prominent (Seetoo, 2001). Relevant research made contributions to this field, such as corporate performance indicators, benefits of collaboration, value systems, supply chain collaboration, and social network analysis (Graça & Camarinha-Matos, 2017; Neely & Hill, 2001).

The evaluation indicators of the business ecosystem and business strategy impact indicator corresponding explanation are shown in Tables 1.1 and 1.2.

Table 1.1
EVALUATION INDICATORS OF BUSINESS ECOSYSTEM

Dimension	Influencing Indicators	Literature
Innovation	Investment in Research & Development (R&D)	Nelly (1998), Mairesse & Mohnen (2001), Crepon (1998), Duguet (2002), Geroski (1989)
	Cost of innovation	
	Patents and application	
	The sale of imitated and innovative products	
	New product launch	
Productivity	Factor productivity	Iansiti & Levien (2004a), Pierce (1988), Dedehayir et al., (2018), Choi et al. (2018)
	Productivity change	
	Diffusion of innovation	
Robustness	Survival rate	Iansiti & Levien (2004b), Wieland & Wallenburg (2012), Alippi (2014), Durach & Machuca, (2015), Kannangara & Uguccioni (2013), Lappi et al. (2017)
	The durability of the ecosystem structure	
	Predictability	
	Continuity of use experience and cases	
Niche creation	Vendor diversity	Iansiti & Levien (2004b), Iyer et al. (2006), Kou et al. (2010), Vargo et al. (2018)
	Variety of products and technologies	
	Technology	
	Partner	
	Reputation	
	Knowledge	
Collaboration	Enterprise performance indicator	Graça & Camarinha-Matos (2017), Kaplan & Norton (1996), Abreu & Camarinha-Matos (2008), Jackson (2008)
	Benefits of collaboration	
	Value system	
	Supply chain collaboration	
	Social network analysis	

Table 1.2
DESCRIPTION OF THE INDICATORS THAT INFLUENCE BUSINESS STRATEGIES

Dimension	Influencing Factor	Explanation
Innovation	R&D investment	The investment that enterprises put into R&D
	The total cost of innovation	The cost that enterprises put into innovation excluding R& D
	Patents and application	Enterprise patents and patent applications
	The sale of imitated or innovative	The number of imitated or innovative products that are sold

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	products	
	New product launch	The number of new products that are launched
Productivity	Factor productivity	Analyzing the ability of business ecosystem members to convert the factors of production into products or services
	Productivity change	A change in trend of productivity factors
	Diffusion of innovation	Whether new technologies can be diffused among the business ecosystem members in a quick and effective manner
Robustness	Survival rate	Whether there is a great chance of survival
	The durability of the ecosystem structure	Whether the changes in the external environment can be withstood
	Predictability	To which extent it can be predicted or controlled
	Continuity of use experience and cases	When consumers encounter new technology, their experience has gradual changes rather than drastic and significant changes.
Niche creation	Vendor diversity	The changes in the type of newly established enterprises within a period
	Variety of products and technologies	Changes in the type of newly created products or technologies within an ecosystem in a period
	Technology	Launching new products
	Partner	Increasing the customer base
	Reputation	Strengthening the trust of distributors and consumers
	Knowledge	Learning technical and managerial knowledge to improve technical and managerial abilities
Collaboration	Performance indicator	The Balanced Score Card is used as evaluation criteria.
	Benefits of collaboration	Identify the benefits brought by all kinds of work and collaboration
	Value system	Including those who generate value, performance evaluation, and moral values
	Supply chain collaboration	Seen as a relevant input business ecosystem indicator for performance refinement
	Social network analysis	Based on random strategies, costs, and benefits

METHODOLOGY

This study evaluates the dimensions of a business ecosystem. According to the above literature, the dimensions of the evaluation table are roughly determined based on the life cycle of the business ecosystem, namely birth, expansion, leadership, and self-renewal or death. First, the fuzzy Delphi (FDelphi) method is used to find out the evaluation factors of the four phases. After that, the table is established with the fuzzy analytic hierarchy process (FAHP). Afterward, the characteristics of the ecological life cycle are approached in terms of innovation, productivity, robustness, niche creation, and collaboration to clarify the importance of each dimension (Peltoniemi, 2005). Results can be a reference for companies in implementing a business system as shown in Figure 1 and the evaluation dimensions of a business ecosystem as shown in Table 2.1 and Table 2.2.

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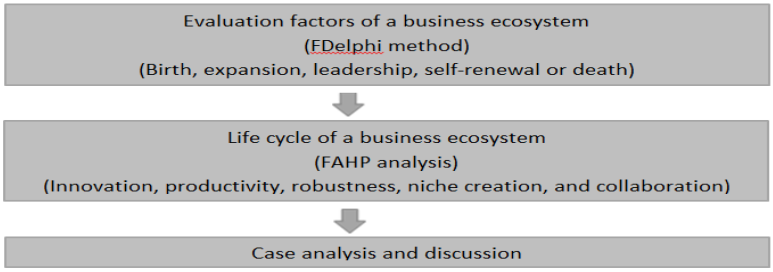

FIGURE 1
RESEARCH PROCESS

Table 2.1
EVALUATION DIMENSIONS AND INDICATORS OF A BUSINESS ECOSYSTEM

Dimension	Indicator
Innovation	R&D investment
	Total cost of innovation
	Patents and application
	The sale of imitated and innovative products
	New product launch
Productivity	Factor productivity
	Productivity change
	The diffusion of innovation
Robustness	Survival rate
	Durability of the ecosystem structure
	Predictability
	Continuity of use experience and cases
Niche creation	Vendor diversity
	Diversity of products and technology
	Technology
	Partner
	Reputation
	Knowledge
Collaboration	Performance indicator
	Benefits of collaboration
	Value system
	Supply chain collaboration
	Social network analysis

Table 2.2
EVALUATION DIMENSIONS AND INDICATORS OF A BUSINESS ECOSYSTEM

Dimension	Life Cycle Indicator	Birth	Expansion	Leadership	Self-Renewal Or Death
Innovation	R&D investment				
	Total cost of innovation				
	Patents and application				
	Imitated and innovative products				
	New product launch				
Productivity	Factor productivity				

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	Productivity change				
	Diffusion of innovation				
Robustness	Survival rate				
	Durability of the ecosystem structure				
	Predictability				
	Continuity of use experience and cases				
Niche creation	Vendor diversity				
	Diversity of products and technology				
	Technology				
	Partner				
	Reputation				
	Knowledge				
Collaboration	Performance indicator				
	Benefits of collaboration				
	Value system				
	Supply chain collaboration				
	Social network analysis				

FDELPHI AND FAHP RESULTS AND CORRESPONDING ANALYSIS

Research Samples of the FDelphi Questionnaire

The respondents of this research questionnaire are seniors in the industry related to the business ecosystem and their length of services is more than five years. According to empirical cases and relevant research using the FDelphi method, an expert panel should at least consist of 5 to 10 members to implement the FDelphi and FAHP methods. Moreover, Zhang & Liu (2004) pointed out that 3 to 7 members would be the best for the utilization of the FAHP method. Consequently, this study distributed 11 questionnaires to 11 experts five of which were collected and found valid (Salager-Meyer, 1988).

Results and Analysis of FDelphi Questionnaires

Table 3.1
LIFE CYCLE FACTORS OF A BUSINESS ECOSYSTEM

Business Ecosystem	Factor	Verification Value $M^i - Z^i$	Expert Consensus G^t	Survey Results
Birth	Entrepreneurs pay attention to customer needs	2.6	7.7	Convergent
	A good entrepreneur is the person who best defines and delivers a short-term customer value proposition.	2.3	6.9	Convergent
	The value guide that partners work together to provide services to customers start during this period.	0.2	6.1	Convergent
Expansion	To maintain existing markets, entrepreneurs will compete with other ecosystems.	1.6	6.7	Convergent
	Stimulating customer demands for products	2.9	7.7	Convergent

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	or services provided			
	Satisfying customer needs with sufficient supply	-0.6	6.8	Unconvergent
Leadership	Competing for leadership within the business ecosystem	1.5	7.0	Convergent
	Through expansion, ecosystem members take over the operating activities of the closest members in the value chain, thus, providing customers with a variety of value elements.	2.1	6.8	Convergent
	The leading company provides guidance in the investment direction and technical standards of the ecosystem.	0.4	6.6	Convergent
Self-renewal or death	Members pay close attention to new trends that may overturn the entire ecosystem.	0.1	7.5	Convergent
	Building a new management team and even new ecosystems if necessary	-3.1	6.4	Unconvergent
	Balancing the relationship between stability and ability to transform by adopting new innovations consistently.	1.6	7.7	Convergent

This study screened out the 10 factors of the life cycle of a business ecosystem through a round of fuzzy Delphi questionnaires; two factors were deleted based on the suggestion of experts. Most factors that reach convergence in this study are higher than 6, indicating that the converged factors are of certain importance. Therefore, this study refers to the research by Cheng-Wei Lin (2005), setting the threshold value to 6 and the factors with a consensus value of less than 6 are deleted as shown in Table 3.1.

FAHP QUESTIONNAIRE, RESULTS, AND ANALYSIS

Research Samples of the FAHP Questionnaire Survey

This study used the FAHP to establish the evaluation table of the business ecosystem. Therefore, the questionnaire was designed based on the FAHP framework and the evaluation dimensions and influencing indicators were compared pairwise. In this way, the evaluation weights on each dimension and each influencing indicator were determined. This study divides the questionnaire into five parts, as shown in Appendix A. The first part explains the structure of the questionnaire; the second part describes the research dimensions and influencing indicators of the study, which consists of five dimensions and 23 evaluation indicators. The third part explains the way the FAHP questionnaire should be filled out. Evaluation dimensions and indicators are compared pairwise with a nominal scale, which consists of "*absolutely important*", "*extremely important*", "important", "*slightly important*", and "*equally important*" and they are assigned to 9,7,5,3, and 1 point, respectively. Plus, 8,6,4 and 2 points are set as the value between the two levels of importance. Consequently, there are a total of 9 levels of importance for a nominal scale. The fourth part is composed of survey items in which respondents fill in the importance of evaluation dimensions and indicators that are compared pairwise. The fifth part asks the respondents to write down their basic background information (Quinn & Cameron, 1983).

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The number of experts in empirical cases and relevant research is set at 5 to 15 (Naghadehi et al., 2009). Therefore, the questionnaires were distributed to 30 experts in the business ecosystem to fill out 19 of which were collected. Among the collected questionnaires, 18 were valid, 2 of which were filled out by founders, 4 by senior managers, and 10 by managers.

Results and Corresponding Analysis of the FAHP Questionnaire

Through the literature review, this study develops an evaluation table for the influencing indicators of a business ecosystem. These dimensions are divided into four kinds based on the life cycle, namely birth period, expansion period, leadership period, and self-renewal or death period. The table consists of five evaluation dimensions based on the business ecosystem, namely innovation, productivity, robustness, niche creation, and collaboration, and 23 evaluation indicators for pairwise comparison. The mathematical process was completed with the FAHP method and the opinions of 18 experts were analyzed and summarized. The weights for the evaluation dimensions and indicators are shown in Tables 3.2, 3.3, 3.4, and 3.5.

Table 3.2
THE DISTRIBUTIONAL WEIGHTS OF EVALUATION DIMENSIONS AND INDICATORS IN THE BIRTH PERIOD OF A BUSINESS ECOSYSTEM

Dimension	Dimensional Weights	Evaluation Indicators	Indicator Weights	Distributional Weights
Innovation (A1)	0.3070	R&D investment (A1.1)	0.1540	0.0473
		Total cost of innovation (A1.2)	0.1436	0.0441
		Patents and application (A1.3)	0.2312	0.0710
		Sale of imitated and innovative products (A1.4)	0.2057	0.0631
		New product launch (A1.5)	0.2654	0.0815
Productivity (A2)	0.1203	Factor productivity (A2.1)	0.3043	0.0366
		Productivity change (A2.2)	0.2335	0.0281
		Diffusion of innovation (A2.3)	0.4622	0.0556
Robustness (A3)	0.1325	Survival rate (A3.1)	0.3881	0.0514
		Durability of the ecosystem structure (A3.2)	0.2288	0.0303
		Predictability (A3.3)	0.1866	0.0247
		Continuity of use experience and cases (A3.4)	0.1965	0.0260
Niche creation (A4)	0.2516	Vendor diversity (A4.1)	0.1552	0.0390
		Diversity of products and R&D investments (A4.2)	0.1377	0.0346
		Technology (A4.3)	0.1955	0.0492
		Partner (A4.4)	0.1668	0.0420
		Reputation (A4.5)	0.1733	0.0436
		Knowledge (A4.6)	0.1715	0.0431
Collaboration (A5)	0.1886	Performance indicator (A5.1)	0.1314	0.0248
		Benefits of collaboration (A5.2)	0.1537	0.0290
		Value system (A5.3)	0.1941	0.0366

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		Supply chain collaboration (A5.4)	0.2758	0.0520
		Social network analysis (A5.5)	0.2450	0.0462

Table 3.3
THE DISTRIBUTIONAL WEIGHTS OF EVALUATION DIMENSIONS AND INDICATORS IN THE EXPANSION PERIOD OF THE BUSINESS ECOSYSTEM

Dimension	Dimensional Weights	Evaluation Indicators	Indicator Weight	Distributional Weight
Innovation (A1)	0.2643	R&D investment (A1.1)	0.2481	0.0656
		Total cost of innovation (A1.2)	0.2066	0.0546
		Patents and application (A1.3)	0.2264	0.0598
		Sale of imitated and innovative products (A1.4)	0.1526	0.0403
		New product launch (A1.5)	0.1664	0.0440
Productivity (A2)	0.1496	Factor productivity (A2.1)	0.3388	0.0507
		Productivity change (A2.2)	0.3224	0.0482
		Diffusion of innovation (A2.3)	0.3388	0.0507
Robustness (A3)	0.1568	Survival rate (A3.1)	0.2585	0.0405
		Durability of the ecosystem structure (A3.2)	0.2425	0.0380
		Predictability (A3.3)	0.2205	0.0346
		Continuity of use experience and cases (A3.4)	0.2786	0.0437
Niche creation (A4)	0.2116	Vendor diversity (A4.1)	0.1319	0.0279
		Diversity of products and R&D investments (A4.2)	0.1285	0.0272
		Technology (A4.3)	0.2091	0.0442
		Partner (A4.4)	0.1680	0.0355
		Reputation (A4.5)	0.1784	0.0377
		Knowledge (A4.6)	0.1841	0.0390
Collaboration (A5)	0.2177	Performance indicator (A5.1)	0.2155	0.0469
		Benefits of collaboration (A5.2)	0.2253	0.0490
		Value system (A5.3)	0.2127	0.0463
		Supply chain collaboration (A5.4)	0.2029	0.0442
		Social network analysis (A5.5)	0.1437	0.0313

Table 3.4
THE DISTRIBUTIONAL WEIGHTS OF EVALUATION DIMENSIONS AND INDICATORS IN THE LEADERSHIP PERIOD OF THE BUSINESS ECOSYSTEM

Dimension	Dimensional Weights	Evaluation Indicators	Indicator Weight	Distributional Weight
Innovation	0.2483	R&D investment (A1.1)	0.3285	0.0816

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(A1)		Total cost of innovation (A1.2)	0.1856	0.0461
		Patents and application (A1.3)	0.1865	0.0463
		Sale of imitated and innovative products (A1.4)	0.1086	0.0270
		New product launch (A1.5)	0.1908	0.0474
Productivity (A2)	0.1711	Factor productivity (A2.1)	0.2062	0.0353
		Productivity change (A2.2)	0.2828	0.0484
		Diffusion of innovation (A2.3)	0.5111	0.0875
Robustness (A3)	0.2223	Survival rate (A3.1)	0.2524	0.0561
		Durability of the ecosystem structure (A3.2)	0.2331	0.0518
		Predictability (A3.3)	0.2164	0.0481
		Continuity of use experience and cases (A3.4)	0.2980	0.0662
Niche creation (A4)	0.1920	Vendor diversity (A4.1)	0.1006	0.0193
		Diversity of products and R&D investments (A4.2)	0.1135	0.0217
		Technology (A4.3)	0.2009	0.0385
		Partner (A4.4)	0.2091	0.0401
		Reputation (A4.5)	0.1963	0.0376
		Knowledge (A4.6)	0.1796	0.0345
Collaboration (A5)	0.1663	Performance indicator (A5.1)	0.2338	0.0388
		Benefits of collaboration (A5.2)	0.1969	0.0328
		Value system (A5.3)	0.2047	0.0340
		Supply chain collaboration (A5.4)	0.2150	0.0358
		Social network analysis (A5.5)	0.1495	0.0249

Table 3.5
THE DISTRIBUTIONAL WEIGHTS OF EVALUATION DIMENSIONS AND INDICATORS IN THE SELF-RENEWAL OR DEATH PERIOD OF THE BUSINESS ECOSYSTEM

Dimension	Dimensional Weights	Evaluation Indicators	Indicator Weight	Distributional Weight
Innovation (A1)	0.3101	R&D investment (A1.1)	0.3207	0.0995
		Total cost of innovation (A1.2)	0.1812	0.0562
		Patents and application (A1.3)	0.1612	0.0450
		Sale of imitated and innovative products (A1.4)	0.1341	0.0416
		New product launch (A1.5)	0.2028	0.0629
Productivity (A2)	0.1212	Factor productivity (A2.1)	0.3785	0.0459
		Productivity change (A2.2)	0.3051	0.0370
		Diffusion of innovation (A2.3)	0.3164	0.0383
Robustness (A3)	0.1696	Survival rate (A3.1)	0.2848	0.0483
		Durability of the ecosystem structure (A3.2)	0.2822	0.0479
		Predictability (A3.3)	0.1990	0.0338
		Continuity of use experience and cases (A3.4)	0.2340	0.0397
Niche creation (A4)	0.2372	Vendor diversity (A4.1)	0.1447	0.0343
		Diversity of products and	0.1516	0.0360

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		R&D investments (A4.2)		
		Technology (A4.3)	0.1895	0.0449
		Partner (A4.4)	0.1768	0.0419
		Reputation (A4.5)	0.1844	0.0437
		Knowledge (A4.6)	0.1529	0.0363
Collaboration (A5)	0.1619	Performance indicator (A5.1)	0.2034	0.0329
		Benefits of collaboration (A5.2)	0.1747	0.0283
		Value system (A5.3)	0.1816	0.0294
		Supply chain collaboration (A5.4)	0.2409	0.0390
		Social network analysis (A5.5)	0.1995	0.0323

EVALUATION PROCEDURE

Enterprises decide which period of the life cycle a business ecosystem currently is in. The dimensions of the life cycle of a business ecosystem and indicator weights are shown from Tables 3.2 to 3.5. The distributional weight is obtained by multiplying dimensional weights with indicator weights (Iansiti & Richards, 2006). The score of each indicator as shown in Tables 3.6 to 3.9 is obtained by multiplying the distributional weight with the score of each indicator (1-10 points). The summation of the scores for each indicator is the total score for this period, which indicates whether an enterprise is healthy in this period and serves as the reference for its later development as shown in Figure 2.

Table 3.6
THE EVALUATION TABLE FOR THE BIRTH PERIOD OF A BUSINESS ECOSYSTEM

Dimension	Evaluation Indicators	Distributional Weight	Company
Innovation (A1)	R&D investment (A1.1)	0.0473	
	Total cost of innovation (A1.2)	0.0441	
	Patents and application (A1.3)	0.0710	
	Sale of imitated and innovative products (A1.4)	0.0631	
	New product launch (A1.5)	0.0815	
Productivity (A2)	Factor productivity (A2.1)	0.0366	
	Productivity change (A2.2)	0.0281	
	Diffusion of innovation (A2.3)	0.0556	
Robustness (A3)	Survival rate (A3.1)	0.0514	
	Durability of the ecosystem structure (A3.2)	0.0303	
	Predictability (A3.3)	0.0247	
	Continuity of use experience and cases (A3.4)	0.0260	
Niche creation (A4)	Vendor diversity (A4.1)	0.0390	
	Diversity of products and R&D investments (A4.2)	0.0346	
	Technology (A4.3)	0.0492	
	Partner (A4.4)	0.0420	
	Reputation (A4.5)	0.0436	
	Knowledge (A4.6)	0.0431	
Collaboration (A5)	Performance indicator (A5.1)	0.0248	
	Benefits of collaboration (A5.2)	0.0290	
	Value system (A5.3)	0.0366	
	Supply chain collaboration (A5.4)	0.0520	

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	Social network analysis (A5.5)	0.0462	
Total score			

Table 3.7
THE EVALUATION TABLE FOR THE EXPANSION PERIOD OF A BUSINESS ECOSYSTEM

Dimension	Evaluation Indicators	Distributional Weight	Company
Innovation (A1)	R&D investment (A1.1)	0.0656	
	Total cost of innovation (A1.2)	0.0546	
	Patents and application (A1.3)	0.0598	
	Sale of imitated and innovative products (A1.4)	0.0403	
	New product launch (A1.5)	0.0440	
Productivity (A2)	Factor productivity (A2.1)	0.0507	
	Productivity change (A2.2)	0.0482	
	Diffusion of innovation (A2.3)	0.0507	
Robustness (A3)	Survival rate (A3.1)	0.0405	
	Durability of the ecosystem structure (A3.2)	0.0380	
	Predictability (A3.3)	0.0346	
	Continuity of use experience and cases (A3.4)	0.0437	
Niche creation (A4)	Vendor diversity (A4.1)	0.0279	
	Diversity of products and R&D investments (A4.2)	0.0272	
	Technology (A4.3)	0.0442	
	Partner (A4.4)	0.0355	
	Reputation (A4.5)	0.0377	
	Knowledge (A4.6)	0.0390	
Collaboration (A5)	Performance indicator (A5.1)	0.0469	
	Benefits of collaboration (A5.2)	0.0490	
	Value system (A5.3)	0.0463	
	Supply chain collaboration (A5.4)	0.0442	
	Social network analysis (A5.5)	0.0313	
Total score			

Table 3.8
THE EVALUATION TABLE FOR THE LEADERSHIP PERIOD OF A BUSINESS ECOSYSTEM

Dimension	Evaluation Indicators	Distributional Weight	Company
Innovation (A1)	R&D investment (A1.1)	0.0816	
	Total cost of innovation (A1.2)	0.0461	
	Patents and application (A1.3)	0.0463	
	Sale of imitated and innovative products (A1.4)	0.0270	
	New product launch (A1.5)	0.0474	
Productivity (A2)	Factor productivity (A2.1)	0.0353	
	Productivity change (A2.2)	0.0484	
	Diffusion of innovation (A2.3)	0.0875	
Robustness (A3)	Survival rate (A3.1)	0.0561	
	Durability of the ecosystem structure (A3.2)	0.0518	
	Predictability (A3.3)	0.0481	
	Continuity of use experience and cases (A3.4)	0.0662	
Niche creation (A4)	Vendor diversity (A4.1)	0.0193	
	Diversity of products and R&D investments (A4.2)	0.0217	
	Technology (A4.3)	0.0385	

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	Partner (A4.4)	0.0401	
	Reputation (A4.5)	0.0376	
	Knowledge (A4.6)	0.0345	
Collaboration (A5)	Performance indicator (A5.1)	0.0388	
	Benefits of collaboration (A5.2)	0.0328	
	Value system (A5.3)	0.0340	
	Supply chain collaboration (A5.4)	0.0358	
	Social network analysis (A5.5)	0.0249	
Total score			

Table 3.9
THE EVALUATION TABLE FOR THE SELF-RENEWAL OR DEATH PERIOD OF A BUSINESS ECOSYSTEM

Dimension	Evaluation Indicators	Distributional Weight	Company
Innovation (A1)	R&D investment (A1.1)	0.0995	
	Total cost of innovation (A1.2)	0.0562	
	Patents and application (A1.3)	0.0450	
	Sale of imitated and innovative products (A1.4)	0.0416	
	New product launch (A1.5)	0.0629	
Productivity (A2)	Factor productivity (A2.1)	0.0459	
	Productivity change (A2.2)	0.0370	
	Diffusion of innovation (A2.3)	0.0383	
Robustness (A3)	Survival rate (A3.1)	0.0483	
	Durability of the ecosystem structure (A3.2)	0.0479	
	Predictability (A3.3)	0.0338	
	Continuity of use experience and cases (A3.4)	0.0397	
Niche creation (A4)	Vendor diversity (A4.1)	0.0343	
	Diversity of products and R&D investments (A4.2)	0.0360	
	Technology (A4.3)	0.0449	
	Partner (A4.4)	0.0419	
	Reputation (A4.5)	0.0437	
	Knowledge (A4.6)	0.0363	
Collaboration (A5)	Performance indicator (A5.1)	0.0329	
	Benefits of collaboration (A5.2)	0.0283	
	Value system (A5.3)	0.0294	
	Supply chain collaboration (A5.4)	0.0390	
	Social network analysis (A5.5)	0.0323	
Total score			

Table 4
THE EVALUATION TABLE FOR THE EXPANSION PERIOD OF A BUSINESS ECOSYSTEM

Dimension	Evaluation Indicators	Distributional Weight	Company
Innovation (A1)	R&D investment (A1.1)	0.0656	8
	Total cost of innovation (A1.2)	0.0546	8
	Patents and application (A1.3)	0.0598	7
	Sale of imitated and innovative products (A1.4)	0.0403	7
	New product launch (A1.5)	0.0440	8
Productivity (A2)	Factor productivity (A2.1)	0.0507	8
	Productivity change (A2.2)	0.0482	8
	Diffusion of innovation (A2.3)	0.0507	9

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Robustness (A3)	Survival rate (A3.1)	0.0405	8
	Durability of the ecosystem structure (A3.2)	0.0380	8
	Predictability (A3.3)	0.0346	8
	Continuity of use experience and cases (A3.4)	0.0437	8
Niche creation (A4)	Vendor diversity (A4.1)	0.0279	8
	Diversity of products and R&D investments (A4.2)	0.0272	9
	Technology (A4.3)	0.0442	9
	Partner (A4.4)	0.0355	8
	Reputation (A4.5)	0.0377	9
	Knowledge (A4.6)	0.0390	8
Collaboration (A5)	Performance indicator (A5.1)	0.0469	9
	Benefits of collaboration (A5.2)	0.0490	9
	Value system (A5.3)	0.0463	9
	Supply chain collaboration (A5.4)	0.0442	8
	Social network analysis (A5.5)	0.0313	9
Total score			8.23

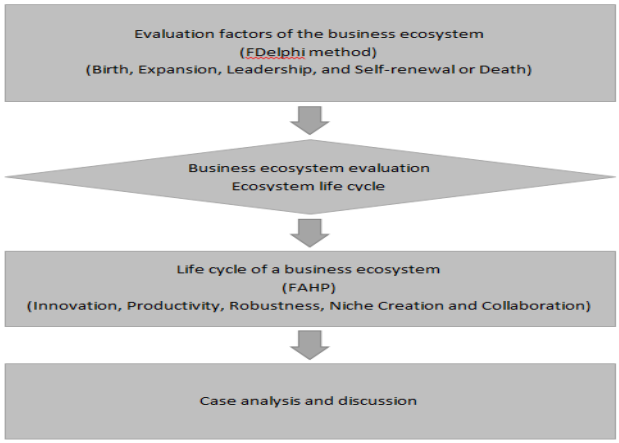

FIGURE 2
THE EVALUATION PROCEDURE OF THE LIFE CYCLE OF THE BUSINESS ECOSYSTEM

CONCLUSION

The fuzzy Delphi method was used to determine the case is in the expansion period. In this period, the dimensions ranked in the order of importance are innovation, collaboration, niche creation, robustness, and productivity, respectively. The most important indicator of innovation is R&D investment, indicating it as the core of innovation. The benefit of collaboration is the most important indicator of collaboration. The most important influencing indicator of niche creation is technology, which indicates that enterprises need technology to increase their competitiveness. Continuity of use experience and cases is the most important influencing indicator of robustness, indicating that a large number of cases are of great importance. Factor productivity is the most important indicator of productivity, showing that converting factors of production into products or services is of vital importance. In addition, continuity of use experience and cases is the most important for the expansion period.

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A company is evaluated with the evaluation table for the expansion period. As shown in Table 4, it has a healthy business ecosystem. As mentioned above, R&D investment is the most influencing factor of innovation for a company, continuity of use experience and cases is for robustness, technology to niche creation, and benefits of collaboration to collaboration. Instead of factor productivity, the diffusion of innovation is the most important factor to the dimension of productivity. Therefore, the evaluation table provided in this research can be used to help determine whether a business ecosystem is healthy.

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