Establishing Standardization and an Innovation Ecosystem for the Global Bicycle Industry—The Case of Taiwan

Yu-Shan Su, Eun-Teak Oh, and Ren-Jye Liu

***Abstract*—China has become a workshop for the world, and manufacturing in the country is increasingly moving beyond labor-intensive, low value-added products. As a result, companies in different industries around the world are facing increasing competition. Taiwan's bicycle industry is a good example. Taiwan's A-Team aims to establish standardization to achieve the functions of an industrial platform in the bicycle industry. Taiwan's A-Team forms an innovation ecosystem through the participation of domestic and foreign complementary companies and suppliers. The companies of Taiwan's A-Team focus on high value-added products in the global bicycle industry by competing and cooperating with each other in the innovation ecosystem. A study of Taiwan's A-Team provides a number of insights into how this goal is achieved.**

***Index Terms*—Global bicycle industry, innovation, innovation ecosystem, standardization, Taiwan.**

I. Introduction

INNOVATION ecosystems have emerged through the dynamic processes of innovation and value creation between multiple and interconnected companies and entities [1], [2]. The companies of Taiwan's A-Team are attempting to shift from low-priced mass production to high value-added production by competing and cooperating with each other in the innovation ecosystem. Taking A-Team as an example, we analyzed how industrial standardization and an industrial platform are established in the innovation ecosystem of the bicycle industry. We further analyzed the characteristics of competition and cooperation coexistence in an innovation ecosystem.

Taiwan's companies focus on the medium- and high-end bicycle markets. The best bicycles in the world are nearly all assembled by Taiwan's manufacturers. Taiwan's manufacturers are capable of handling the requirements of leading companies for assembly or special product specifications. In the past, bicycles were considered to be only for transportation purposes. When the demand for transportation purposes was transferred to exercise or health purposes, the market became extremely different. The reason for this is that exercise- or health-oriented bicycles must be versatile and lightweight. Market demand for sport bicycles has raised the prices of bicycles. That being the case, Taiwan's companies have focused on the high-end market segments of the European and American markets.

Taiwan's bicycle industry has developed over the past 50 years. Industrial standardization can help to enhance global industry position. Through industrial standardization, most companies are able to achieve better cost performance. On the basis of industrial standardization, manufacturers and suppliers are committed to investing in innovation and product differentiation. Manufacturers should establish their competitive advantage by making common products increasingly popular through industrial standardization. Innovation is the key to surpassing fierce competition from homogeneous products. Accordingly, bicycle manufacturers can focus on innovation supported by the standard established industry.

During the 1980s and early 1990s, the emergence of many specialized yet flexible supplier networks, which are called "modular, symbiotic supplier networks," have helped to create competitiveness for Taiwanese industries [3]. Because such networks enable the companies and the suppliers to work independently, the companies and the suppliers can coevolve and develop ties with several different industries. Towards the end of the 1990s, the delta areas of the Yangtze River and Pearl River of China formed ever larger industrial clusters, gradually taking over the global position of manufacturing previously held by Taiwanese companies. Accordingly, Taiwan's companies and suppliers began to face a serious challenge that could potentially become a serious obstacle to industrial upgrades and transformations [4].

A-Team is a collaborative association consisting of the manufacturers and suppliers of Taiwan's bicycle industry. A-Team was established in 2002 to revitalize Taiwan's industry prospects. Taiwan's A-Team has been described as a good example of an innovation ecosystem. In fact, Taiwan's A-Team is rewriting the history of the industry on the island by leading the entire industry into the future. Moreover, it has also become a significant indicator of industrial upgrades and transformations.

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In this article, we analyze how Taiwan's A-Team has helped to establish industrial standardization and an industrial platform to further facilitate the establishment of an innovation ecosystem for the global bicycle industry.

Therefore, we propose our research question: How has Taiwan's A-Team established industrial standardization and an innovation ecosystem for the global bicycle industry? The purpose of this article are as follows.

1) Industrial standardization is being established in the industry.
2) An innovation ecosystem is being established in the industry.
3) Core companies contribute to an industrial platform in the innovation ecosystem.
4) The complementors of the industrial platform of the innovation ecosystem generate external network effects. We also propose theoretical and practical implications of this type of innovation ecosystem on the continued development of manufacturing in Taiwan.

The rest of this article is organized as follows. Section II provides a theoretical context for the research in terms of innovation ecosystems and standardization. Section III describe the case study of Taiwan's A-Team. Section IV describe the findings of the case study. Finally, Section V concludes this article.

II. Theory

A. Innovation Ecosystems

An innovation ecosystem is defined as a group of multiple companies or business units with suppliers and buyers that can form flexible and various types of alliances and cooperation to provide consumers with more diversified products [5]–[8].

Innovation ecosystems are generally defined as complex relationships between multiple interconnected members and entities for which its functional goal is to enable the development of technologies and innovations [1], [2], [5]. Innovation ecosystems can refer to the ecosystems formed by the overall processes of social and economic systems. Prior research emphasized either the integration of the theories of national and regional innovation systems or the nature of the innovation ecosystem, such as competition and cooperation coexistence [1], [2], [10]–[12]. We need more theoretical and empirical evidence for innovation ecosystem research.

Moore [7], [13] has indicated that a new form of innovation, "competition and cooperation coexistence," is defined as multiple enterprises and institutions collaborating through "cooperation and evolution symbiosis." It is the relationship between cross-configured systems in various industries. In the innovation ecosystem, internal enterprises, suppliers, and distribution channels are defined as the "core ecosystem," while secondary and tertiary suppliers, third-party vendors, and customer groups and standard bodies are included in the overall ecosystem.

Iansiti and Levien [8] proposed the keystone strategy, which acts as a strategic guideline for companies to determine the position and scope of the business network hub in the "core enterprise." This core enterprise can provide a platform to execute the strategy and help ecosystem members generate more profit. In this manner, using a core business network to run the critical strategy, the network can sustain a healthy ecosystem with active innovations. Adner and Kapoor [14] proposed that competition and coordination between the core and complementary enterprises play an important part in innovation in the ecosystem and in creating value for customers.

Three significant findings from prior studies on the innovation ecosystem are as follows.

1) Innovation ecosystems are considered to be a new branch of study in innovation theory, business ecosystems, and industry ecosystems. Moreover, innovation ecosystems are expanded beyond the boundaries of a company's value chain and formed on the basis of competition and cooperation coexistence among the large number of participants.
2) From a network perspective, innovation ecosystems focus on interactions among enterprises, institutions, and suppliers in the system as well as the interactions of the core enterprises with the customers [9]. Innovation ecosystems aim to innovate and create value for customers by focusing on market forces [16].
3) The presence of complementary companies in the innovation ecosystem promotes innovation through two complementary skill sets—artistic competence and evolution of technology and information. It is also important for emphasizing the significance of innovation.

We still require more empirical evidence related to competitive and cooperative coexistence in the innovation ecosystem. Prior studies have downplayed the possible presence of various ecosystems depending on the situation and characteristics. Our research contributes to dynamic developments within a variety of industrial networks in the different geographical and national environments.

An industry platform is defined as products, services, or technologies that act as a foundation upon which external innovators, organized as an innovative business ecosystem, can develop their own complementary products, technologies, or services [15]. Industrial platforms and complementors are similar to a group that consists of network relationships and resources among downstream assembly companies and upstream component companies and suppliers. Gawer and Cusumano [15] defined a platform as a group of information assets related to products, services, and technologies; it can be divided into internal and external platforms. The internal platform, or company-specific platform, allows companies to carry out a series of developments towards efficient and diversified products and production under a stable organizational structure. It usually refers to asset assembly that is integrated within the company. In contrast, the external platform, or industry platform, is a way for external users of the companies to achieve the development of complementary products, technologies, and services through the industrial platform [5], [6], [16]. The external platform serves as a basis for providing technologies and services to the members of the industrial ecosystem. The difference between the internal and external platforms is whether the foundation of the platform is disclosed by external companies.

In the innovation ecosystem, companies can share information with each other through the platform. Additionally, they use the

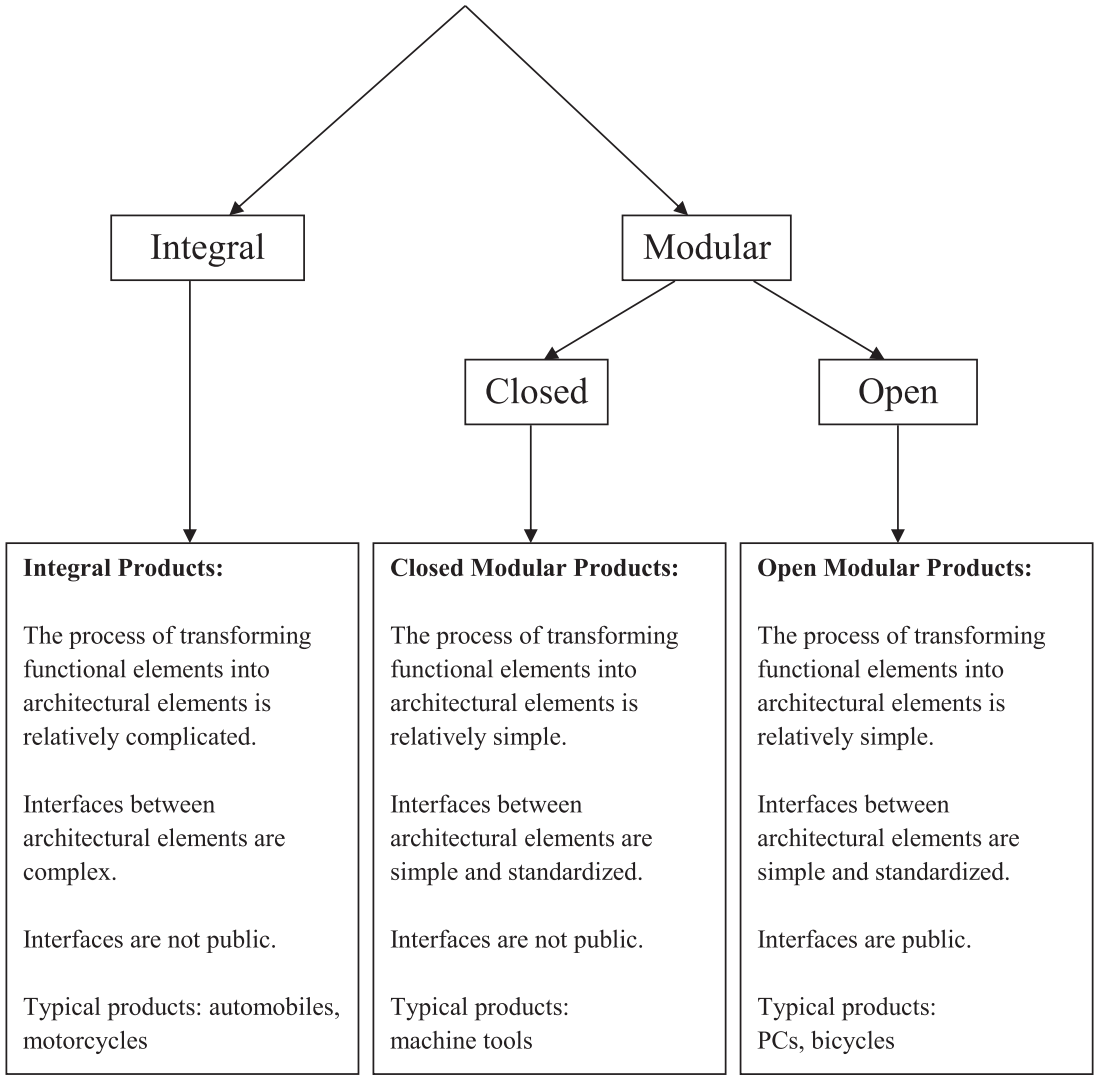

Fig. 1. Summary of product architecture types.
Source: This study.

external effects of the complementors' networks to gain competitive advantages. On the basis of industrial standardization, they can achieve the goal of coexistence and prosperity in the innovation ecosystem to enhance the overall competitiveness of the industry [5]–[8].

Brandenburger and Nalebuff [17] proposed that *co-opetition* is a business strategy that goes beyond the old rules of competition and cooperation to combine the advantages of both. *Co-opetition* is a pioneering, high-profit means of leveraging business relationships [17]. Brandenburger and Nalebuff [17] further argued that "complementor" refers to related companies that can increase the value of the products of the core company through their own products. If the demand of the products for the other companies increases, the demand of the products for the focal company will also increase. Thus, there is a complementary relationship between these companies.

This article focuses on the concrete evidence of competition and cooperation coexistence in the innovation ecosystem on the basis of industrial standardization. What are the differences between the innovation ecosystem and the existing supply chain system? On the innovation ecosystem platform, central companies (downstream bicycle assembly companies) and cooperative companies (upstream components suppliers) exist together. Moreover, the companies in the innovation ecosystem compete and cooperate with each other.

B. Standardization

Standardization includes a wide range of information-sharing processes and strategic alliances for the purpose of establishing the foundation of industrial standardization [18]. Bicycles have been widely recognized as a model for the modular, open product, i.e., a modular product with open standards for connections between components [4]. In general, product architecture can be "Modular" or "Integral," and if "Modular," they can be "Open" or "Closed" [23], [28]–[30] (see Fig. 1). Within such a taxonomy, modular product architectures represent products that can be divided into components and regulated by standard interfaces.

Modular product architecture includes products such as bicycles, personal computers, and machine tools. In contrast, integral product architectures represent products that cannot be easily deconstructed due to the existence of complicated relationships between different parts of the overall system, such as automobiles and motorcycles. In modular products, the degree to which a system's interface is regulated and standardized is higher. In integral products, interactions between functional components are more complicated and more difficult to replicate [31].

Standardization seeks to ensure the interoperability of products [21]. Standardization, which can affect the diffusion of innovation, technology, and economic efficiency, can strengthen and enable the development of an innovation ecosystem. Standardization of the innovation ecosystem is established by a key player who is also a platform leader [5], [6], [15]. Standardization not only can increase efficiency within a technological life cycle, but it also can prolong the existing life cycles to an excessive degree by investing in technological innovations for the next cycle [20]. For example, the standardization of parts enables specialized suppliers to increase efficiency within the entire product life cycle. The standardization of the production processes, which also reduces variety and creates order, offers improvements to performance via routinization, simplification, and economies of scale. Standardization may offer innovation advantages by creating common languages for investigation and experimentation and encouraging incremental improvements based on previous experience [22]. The process of standardization is the pursuit of conformity, which aims to increase the efficiency of economic activities [20].

Standards, which indicate the sharing of specific information and knowledge, usually provide a regulatory role for members who govern the rules to promote convergence towards a common industry or professional norms [19]. An industrial standard is a set of specifications to which all elements of products, processes, formats, and procedures under its jurisdiction must conform. In general, a standard can be viewed as striking a balance among the requirements of users, the technological possibilities, and associated production costs, and constraints imposed by the government for the welfare of society. Standards can enable companies to achieve economies of scale and also enable markets to execute transactions efficiently. A standard interface is the core technical attribute of a module. The standard interface enables modules to be designed independently and consequently, allowing mixing and matching to create a complete product system [24]. Because the standard interface can ease the outsourcing of product development activities to suppliers, it favors vertical disintegration in an innovation ecosystem.

The tendency of standardization and the effects of the standards are spread between product innovators and other users at the open level [25]. Since open designs can represent the sharing of system information, the commonly accepted standards, normally accepted as the dominant design, are significant symbols of openness [26], [27]. If components have open standard interfaces, then these interfaces can be widely diffused within a given industry. An effective interface standard does not affect the design of the components themselves. Interface standards provide "open" systems and enable innovations by allowing multiple designs of proprietary components to coexist [20]. In effect, competitors can innovate on either side of the interface, whereas consumers can select particular components that optimize their system design.

III. Research Method

A. Research Site and Case Selection

Taiwan is called the "kingdom of bicycles" in the international market. The bicycle industry in Taiwan has developed over the past 50 years. Taiwan's bicycle industry is located in central Taiwan. Taiwan is a key area of the bicycle industry where manufacturers, key component suppliers, and subcontracting manufacturers are concentrated. Giant and Merida are the two leading bicycle companies in Taiwan. Both companies are publicly listed, have globally known brand names, and are devoted to sustaining Taiwan's competitiveness in the bicycle industry. For many years, the two companies have viewed each other as respectful rivals, recognizing that it is impossible for a single company to maintain Taiwan's competitiveness in the industry. In the 1990s, Taiwan's bicycle companies actively transformed themselves by investing in R&D innovations and high value-added products under their own brands.

In 2000, the rise of China created a huge appeal for different companies. A large number of Taiwan's bicycle companies and suppliers moved to China. The output of Taiwan's bicycle companies declined due to competition from low-prices and the relocation of manufacturers to China. Taiwan's bicycle industry was forced to transform its organizations and focus on product innovation. Within that context, the A-Team was founded by the two core companies, Giant and Merida, to bring "competition and cooperation coexistence" into the innovation ecosystem of Taiwan's bicycle industry.

Giant's Chairman King Liu and Merida's Chairman Michael Tseng invited many key component suppliers to establish an organization named A-Team to promote industrial cooperation and the sharing of information to revitalize the industry. Taiwan's bicycle industry possesses a comprehensive industrial chain through vertical disintegration. Therefore, when industry leaders Giant and Merida made a clarion call, most suppliers and subcontracting manufacturers responded and followed the actions of these two industry leaders to improve themselves and contribute to industrial upgrades and rooting in Taiwan.

In 2003, Giant and Merida jointly sponsored A-Team to achieve the goals of supplying high value-added products through the use of a differentiation strategy. The members of A-Team improved products and technologies through mutual learning and the upstream, midstream, and downstream integration of the bicycle industry. A-Team was comprised 19 companies in the first round. A-Team was established mainly to reduce costs. Giant, Merida, and other component suppliers have benefitted and upgraded due to the establishment of A-Team. This represents the excellence of A-Team's achievements.

B. Data Collection

We conducted a number of on-site interviews, which were supplemented by telephone interviews and additional documentation (see Table I). There were three interview periods. The

TABLE I
INTERVIEW TIME TABLE

Period	Company	Interviewee	Position	Date	Hours
Period 1	**To Explore A-Team's Founding Background and Purpose**				
	Kuozui Automobile	Takehiko Harada	Former president	April—May 2003	3
		Pai-Rong Wang	Vice president		
	Giant	Antony Lo	President		1
		Qing-Xin Yan	Conductor		1.5
Period 2	**To Explore A-Team's Production Output and Product Developments**				
	Kuozui Automobile	Zhao-Hua Li	Manager	October 2005—September 2006	1.5
	Giant	Antony Lo	President		0.5
		Qing-Xin Yan	Conductor		1.5
		Li-Zhong Xu	Company public relation spokesman		1.5
		Ming-En Zeng	Technical center engineer		2.5
	Merida	Michael Tseng	President		2
		Qi-Bin Yuan	Vice president		
		Ru-Ding Lai	Production manager		
		Bo-Lin Li	Director of exporting and product		3
	Cheng Shin Rubber	Ming-Chun Wong	Vice president		2
		Chang-Zhih Chang	Technical center engineer		
		Zhih-Jian Hsu	Technical center engineer		
Period 3	**To Explore A-Team's Integrated, Co-innovative Supplier Networks, Innovation Ecosystem**				
	A-Team	Wei-Chih Chen	Executive secretary	8th April, 2014	1.5
	Merida	Bo-Lin Li	Vice president	4th April, 2014	3
		Wei-Chih Chen	Production manager		
	FSA	Douglas Chiang	CEO	21st April, 2014	2
	TEKTRO	Jin-Rong Ho	Vice president	22nd April, 2014	2
		Kun-Lang Chen	Assistant of chairman		
	Giant	Li-Zhong Xu	Company public relation spokesman	24th April, 2014	0.5
	SRAM	Hank Kao	CEO	29th April, 2014	3
	FAIRLY BIKE	Steve Chien	Vice president	9th May, 2014	2.5
	SRAM	Hank Kao	CEO	23rd May,2014	5
	TOPEAK	Louis Chuang	Chairman	23rd May,2014	
	Cycling & Health Industrial	Francois Liang	General manager	14th August, 2014	1.5
	Shimano	Yozo Shimano	President	2nd February, 2015	1

Source: This study.

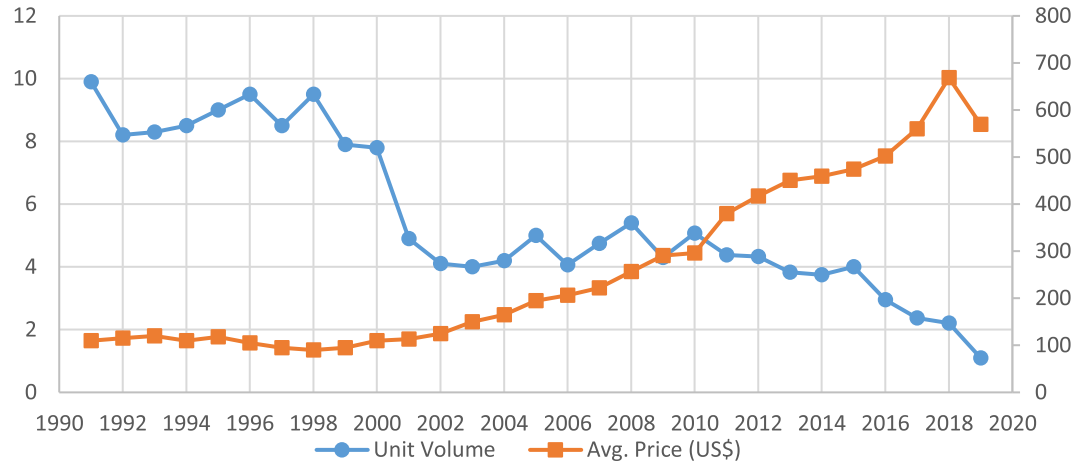

Fig. 2. Export volumes and average unit prices for Taiwanese bicycles.
Source: Taiwan Bicycle Exporters' Association
On the left—amount in million units (ex: top is 12 million)
On the right—U.S. dollars (average unit price)
Date of 2019 are Jan.–Jun.

first interview period started in April and ended in May of 2003. The second interview period started in October 2005 and ended in September 2006. The third interview period started in April 2014 and ended in March 2015. The goal of our fieldwork was to try and develop a better understanding of each manufacturer's strategy for managing its supplier network.

Interviews were conducted with the former president of Kuozui Automobile, Takehiko Harada; vice president Pai-Rong Wang; manager Zhao-Hua Li; Giant's president Antony Lo (Founding President of the A-team); conductor Qinq-Xin Yan (who is also the founding secretary for A-team); company public relations spokesman Li-Zhong Xu; technical center engineer Ming-En Zeng; Merida's president Michael Tseng (founding vice president of the A-team); vice president Qi-Bin Yuan; director of exporting and products Bo-Lin Li; and production manager Ru-Ding Lai and Wei-Chih Chen (who is also executive secretary for A-team); Shimano's president Yozo Shimano; SRAM Taiwan CEO Hank Kao (who is also vice president of A-team); FSA CEO Douglas Chiang; Fairly vice president Steve Chien; Topeak chairman Louis Chuang; Tektro vice president Jin-Rong Ho; and assistant of chairman Kun-Lang Chen.

C. Data Analysis

We interviewed members of the innovation ecosystem of Taiwan's bicycle industry, particularly focusing on the development of market standardization alongside the cooperation network, including the following.

1) Background of the establishment of A-Team.
2) Development of A-Team.
3) Operating strategies of A-Team.
4) The achievements of A-Team.

We first attempted to describe the overall development of A-team and Taiwan's bicycle industry, then worked to explain the current operating situation and efforts of the two manufacturers toward product innovation. Finally, we attempted to link related observations to supply networks.

There are two bicycle manufacturers at the core of Taiwan's A-Team: Giant and Merida. There are 18 suppliers in Taiwan's A-Team. Table II presents some basic information related to each of the suppliers in A-Team. This article is focused on A-Team's two bicycle manufacturers, Giant and Merida, A-Team's suppliers, and non-A-Team manufacturers in Taiwan. A-Team's manufacturers and non-A-Team manufacturers of Taiwan produce almost 95% of the world's medium- to high-end bicycles (see Fig. 2).

IV. Research Findings

In this article, we show that the global bicycle industry derived benefits from Taiwan's A-Team in two aspects: A. Standardization and B. Innovation ecosystem.

A. Benefits Derived From A-Team: Standardization

Taiwan's bicycle industry established a set of standards for the global bicycle industry. Around 90% of product standards in the global bicycle industry have been successfully established based on the concept of "standardized infrastructure." In 1989, Giant's Chairman King Liu was focused on the promotion of standardized infrastructure in the bicycle industry. In 1990, King Liu collaborated with Merida's Chairman Michael Tseng to implement industrial standardization. They made efforts in industrial standardization for more than 10 years before the establishment of A-Team. In 2001, King Liu and Michael Tseng made efforts to establish A-Team in order to implement industrial standardization. "Standardized infrastructure" is the fundamental basis of A-Team, which in turn, benefitted Taiwan's bicycle industry.

"Co-innovation" refers to industrial cooperation between companies for the goal of product development during the growth of Taiwan's bicycle industry, since those companies

TABLE II
A-TEAM MEMBERS

Company Name	Giant	Merida	Full Speed Ahead (FSA)	TEKTRO TECHNOLOGY CORP	FORMULA ENGINEERING INC	SR SUNTOUR INC	Velo Enterprise
Year of Establishment	1972/10/27	1972/09/29	1970/3/12	1986/6/17	1994/4/21	1987/2/27	1979/2/12
Number of Employees	2100	900	280	410	121	400	200
Main Products	Bicycles, motors and produce parts, marketing	Bicycles and produce some parts, some mineral alloy, marketing	Front set, seating pad, wheel set	Breaks, grips, and parts	Hubs and wheel set	Suspension fork parts, transmission	Seating pad, grips
Location	Taichung	Changhua	Taichung	Changhua	Taichung	Changhua	Taichung
Company Name	ALEX Machine	VP COMPONENTS CO., LTD.	KMC International INC.	SRAM (Taiwan)	Kenda Rubber Industrial Company	DAH KEN IND. CO., LTD	Transart Graphics
Year of Establishment	1991/6	1980	1977/8/20	1990/11/1	1962/3/1	1971/10/1	1973
Number of Employees	400	350	205 人/ 5,500	2100	1390	150	185
Main Products	Alloy frame, wheel set	Front parts	chains	Transmission system, motor	Inner tube and outer tire	Suspension fork, rear fork, parts for motorcycle, grips	Narks, wheel cover and chain cover
Location	Tainan	Taichung	Tainan	Taichung	Changhua	Hsinchu	Taichung
Company Name	Leechi	CHIA CHERNE Industry	JOY IND. CO., LTD	Cheng Shin Rubber	JD Components Co., Ltd.	HB Performance Systems Inc. (Taiwan)	
Year of Establishment	1973/5/16	1986/1/1	1971/10//14	1969/12/19	1986	1948	
Number of Employees	600	340	200	4900	300	67	
Main Products	Breaks, cable housings/inner wires	Breaks, cable housings/ inner wires	Hubs	Tires	E-bike, Scooters, elderly scooter / electric cars, bicycles parts	Bicycle shock absorbers, hydraulic / mechanical disc brakes, wheels, wheel sets	
Location	Changhua	Changhua	Taichung	Changhua	Changhua	Taipei	

Source: According to the list of A-Team Services Bureau, the business sites and interviews arrangement.
Notes:
1. The first 11 companies were original members in 2003, and the 12th to 18th joined in 2004 and 2005, and the latest two joined recently. Its total of 20 members in 2014.
2. Sponsors including: SCOTT, TREK, SPECIALIZED, NBDA (National Bicycle Dealers Association), COLNAGO, Shimano, Accell group.
3. KMC is the world's largest bicycle chain factory, chairman Charles Wu, after Giant's president Antony Lo, Merida's president Michael Tseng, he was elected to a third term A-Team's president in 2014.

and suppliers do not compete with each other intensely and have common interests for cooperation. Starting in 1990, standardization has been conducted by Taiwan's bicycle industry. This standardization was important for improving and upgrading Taiwan's component suppliers. From 1970 to 1980, many Taiwanese suppliers were iron factories. After establishing standardization and A-Team, these iron factories have dramatically grown into international suppliers. Through A-Team, both its members and non-members have transformed into advanced suppliers. As such, the overall bicycle industry in Taiwan has been upgraded and gained its strong competitive advantage in the international market.

Taiwan's bicycle industry has been the main contributor to the standardization of the global bicycle industry. Almost 90% of

the product standards of the global bicycle industry have been successfully established by Taiwan. Therefore, manufacturers can easily meet the needs of buyers. Standards in the bicycle industry evolve continuously and most manufacturers have to follow the developments established by the dominant companies. The components of different suppliers can be openly colocated. At present, Shimano, SRAM, and Campagnolo dominate the specification design of derailleur and drive systems. When specifications are dominated by a few larger companies, all other suppliers must follow the dominant design.

How do suppliers innovate? Without innovation, suppliers can only follow dominant companies. The leading global companies with innovation capabilities can force the market to follow their ideas. The market will react to the innovations of global leading companies, so suppliers who follow these companies may have a better future. Conversely, if suppliers choose to lead development through their own innovations instead of following global leading companies, then these suppliers' futures may not be clear. In those 10% of innovation parts (other than 90% of product standards), original design manufacturer will jointly develop innovations with brand dealers' concepts of products or develop self-motivated innovations. Taiwan's manufacturers assemble most products in the medium- to high-end bicycle market.

These suppliers are offered guidance and assistance from Kuozui Motors and the Corporate Synergy Development Center in Toyota Production System, Total Quality Management, and just-in-time system. Giant and Merida's inventory and procurement lead time reduced from one-third to half. Production efficiency increased 40% after suppliers were assisted by Kuozui Motors and the Corporate Synergy Development Center. A-Team learned logistical systems, Kanban operation, and just-in-time from Kuozui Motors, and then applied these concepts to the bicycle industry. Kuozui Motor and Toyota Motor assisted Taiwan's bicycle industry in the implementation of the production management system. The influence of the establishment of A-Team as an industrial platform between manufacturers Giant and Merida and subcontracting manufacturers is significant.

The establishment of A-Team was advantageous because suppliers could improve themselves by following in the footsteps of large companies, such as Giant and Merida. Suppliers improved and gained better efficiency and flexibility. Thus, the lead time was shortened from 60 to 30 days. Manufacturers like Fairly and Ideal, who are not members of A-Team, also reaped profits from purchasing products offered by A-Team suppliers. A-Team has been active for 16 years. As many suppliers who are not members of A-Team have largely improved their products, the suppliers within A-Team have become only a priority option today.

B. Benefits Derived From A-Team: Innovation Ecosystem

Established around two independent centers, Giant and Merida, the innovation ecosystem of Taiwan's A-Team focuses on innovation, technological development, and product development. The innovation ecosystem, with intensive interactions between the manufacturers and the suppliers, supports standardization, coinnovation, and learning.

An innovation ecosystem involves two or more organizations that, through direct and intensive communication and interaction, enables cooperation in the development of a system or subsystem that otherwise cannot be simply developed through the use of common sense or public knowledge. An innovation ecosystem is established since the assembly companies cooperate with the suppliers in manufacturing. An innovation ecosystem possesses potential capabilities that can facilitate product development in the innovation ecosystem. Accordingly, the goal of an innovation ecosystem is to provide products and services which are required by the customers.

Based on our study, a comparison of an innovation ecosystem and traditional supply networks are summarized in Table III. Compared with traditional supplier networks in Taiwanese manufacturing, an innovation ecosystem shows a greater degree of standardization and coinnovation. In general, an innovation ecosystem with integrated, coinnovative supplier networks has two features that differentiate it from traditional modular and symbiotic supplier networks. First, an innovation ecosystem focuses more on value creation through coinnovation, while traditional supplier systems tend to emphasize cost control. Second, an innovation ecosystem has a greater ability to enhance competitive advantages by competing and cooperating on an industrial platform with many complementary companies.

An innovation ecosystem also appears to have several other distinctive characteristics, including stable memberships, intensive cooperation, a tendency toward a centralized network structure, a strong industrial platform with core companies, and the external network effects of many domestic and foreign complementors over time. While responsibilities and tasks are not always easily divided among the members of an innovation ecosystem, an innovation ecosystem appears to hold potential for effective coinnovation across the entire industry.

Taiwan's A-Team provides two functions in managing the supply chain: First, it inculcates an innovative spirit, and second, it strengthens the stabilization of its members; both of which influence A-Team members' learning and innovation. While only approximately 15% of the overall sales of participating suppliers go to the two manufacturers Giant and Merida, the significance of A-Team participation goes beyond just sales. A-Team suppliers can be classified into the following three groups according to their long-term relationship with the two core companies Giant and Merida.

1) Companies that are more oriented toward Giant.
2) Companies that are more oriented toward Merida.
3) Companies that are equal oriented toward Giant and Merida (see Fig. 3).

The interactions between the core companies Giant and Merida and suppliers show clear differences. For example, Giant has a higher level of interaction with its suppliers' networks due to its product development strategy, such as Propel (one of Giant's series) at the product level.

In our study of Taiwan's A-Team, we framed the innovation ecosystems as follows [see Fig. 3(d)]. Its two independent centers Giant and Merida would certainly seem to be one of its most distinctive features. There are two famous examples of the network structure. One is Toyota and Daihatsu in Japan; the other

TABLE III
COMPARISON OF AN INNOVATION ECOSYSTEM AND TRADITIONAL SUPPLIER NETWORKS

Mode		**An innovation ecosystem**	**Traditional supply networks**
Network type		Integrated, co-innovative supplier networks	Modular, symbiotic supplier networks
Network architecture	members	Stable (closed)	May be not stable (open)
	type	Centralized	Decentralized
		Possibility of developing into a multi centered structure (separate product strategy, co-marketing)	---
key to establishing		Based on the trust /evolving with time	Reasonable flow of materials
		lean production, lean development, and co-marketing	modularity
Internal foundation	bottom line	Vision, Strong awareness of risk	---
	trust	Interactive foundation	Result of interaction
	relationship	Long-term intensive	According to need
	Purpose of communication	Learning/development (semi-formal)	According to the need of the transaction
	Content of communication	Diverse and comprehensive information	Quality, cost, and delivery info based on the transaction
	Type of communication	Face to face	No emphasis on face to face communication
problems		Hard to separate, Hard to develop	Similar products competing at a low price

Source: This study.

is Hyundai and Kia in Korea. These pairings garner high levels of attention because of their shared ownership and joint use of particular suppliers, and their multicentered supplier networks. What makes Taiwan's A-Team so different, however, is the complete lack of cross-shareholding and ownership between Giant and Merida. Such autonomy and independence between the two focal manufacturers make the Taiwanese case very distinct.

V. RESEARCH DISCUSSIONS AND CONCLUSION

A. Research Discussion

We propose three research discussions. The first, how did Taiwan's A-Team establish an innovation ecosystem? The second, how did Taiwan's A-Team establish industrial standardization in an innovation ecosystem? The third, how did Taiwan's A-Team act as an industrial platform in an innovation ecosystem? In our study, both industrial standardization and industrial platform are two important factors of an innovation ecosystem.

1) Establishing an Innovation Ecosystem: In the 1980s and 1990s, Taiwan was an important base for international original equipment manufacturers (OEMs). Taiwan's industrial supplier networks have been an important part of the island's appeal as a manufacturing base. And those networks have evolved over time. During the 1980s and 1990s, Taiwan's modular, symbiotic supplier networks demonstrated a number of strengths, including the following.

1) A specialized division of labor.
2) Flexibility.
3) Low transaction costs.
4) Short lead times for production.

With the rise of several new industrial clusters in mainland China, such networks are now facing a big challenge, and the structure of the traditional supplier network may have become an obstacle for industrial upgrading and transforming.

In this article, we have analyzed the developments of Taiwan's A-team. We suggested that an innovation ecosystem is a good model for manufacturing in Taiwan. An innovation ecosystem provides integration among a relatively stable set of members, uses a product differentiation strategy to support a multicentered industrial network, and typically results in higher priced, high value-added integrated solutions for consumers. A key requirement for the ecosystem members continued inclusion in an

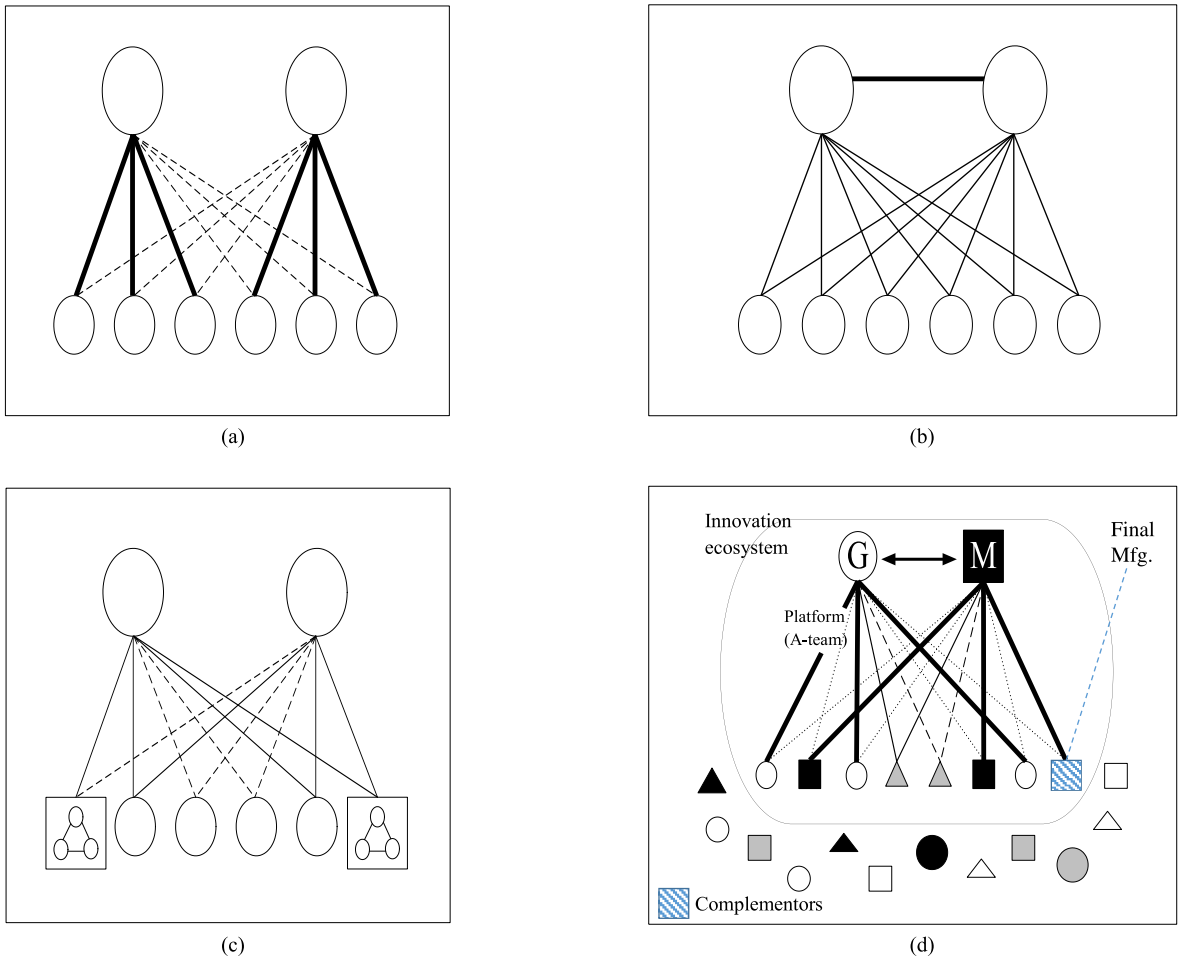

Fig. 3. From supply networks to an innovation ecosystem. (a) Single center supplier network. (b) Dual center supplier network. (c) Multicentered, flexible supplier network. (d) Innovation ecosystem.
Source: This study.
Notes:
1. Mfg. is abbreviation of manufacturing.
2. In Fig. 3(d), the core companies cooperate with many different manufacturers, suppliers, and complementors.

innovation ecosystem is that the value derived from coordinated coinnovation must outweigh the costs. Based on trust among the ecosystem members that typically deepens through cooperation, we can see different types of cooperation and coinnovation emerging over time. From our analysis of Taiwan's bicycle industry, we have found four basic conditions for establishing a successful innovation ecosystem. In particular, there must be the following factors.

1) Industrial standardization.
2) The core companies act as a strong industrial platform.
3) Many domestic and foreign complementors join the industrial platform.
4) A dynamic approach to coinnovation and value creation.

The innovation ecosystem is often bolstered by a centralized network structure. Taiwan's A-Team appears to be a good example of such a model.

One of the most distinctive features of an innovation ecosystem appears to be its emphasis on innovation and learning. An innovation ecosystem would rather pursue long-term, dynamic efficiencies. The interactions between the manufacturers and their suppliers can achieve integrated solutions on an industrial platform of the innovation ecosystem. Of course, there is a special requirement in the innovation ecosystem—to identify market needs quickly enough to ensure that competition from substitute products does not become a problem. Moreover, in trying to maintain or even increase the distance between a company and its competitors, several challenges may present themselves. For example, it can be difficult to separate the strategies of different assembly companies in an innovation ecosystem. Another example is that it can also be difficult to maintain an environment of continuous learning in an innovation ecosystem.

2) Establishing Industrial Standardization: The bicycle industry is an open industry whose standard interfaces and components are openly shared. Industrial standardization arises from market demand. Most of Taiwan's bicycle companies and suppliers have followed the leading companies because design and innovation are market oriented. The standardized product

of innovation ecosystems is evolving alongside the changes in technology and market demand.

The global bicycle industry is an open market that establishes standards according to market demand. Thus, the bicycle industry has gradually become a standardized industry. The industry has established common criteria as a theoretical basis of production and design. To meet the needs of most customers in the market, the standard value may be slightly amended according to market demand at that time. Two types of dynamics of establishing standardization are driven by market demand: first, the leading companies and second, the suppliers of key components. In the first type, the leading companies initiate product specifications to promote the product standards within the industry. In the second type, the leading suppliers of key components develop the standard specifications for the components due to demand from athletes and the sports competition market. Innovations for special designs are often created by varied demands.

The standardization of the bicycle industry depends on market demand. Market demand is usually driven by global leading companies. These companies believe that high-quality products will increase their acceptance in the market. When they increase their market acceptance, the suppliers will follow the standards of the leading companies. And the standards for the products will be established. The global leading companies generally decide the standards of the industry. The global leading companies are the key to deciding which types of products are considered as standards, and the manufacturers only can fully support and follow them. The global leading companies dominate the product specifications and promote these specifications as standards. As other companies and suppliers follow the standards regarding their strategies and benefits, the product will gradually become a mainstream commodity.

3) Acting as an Industrial Platform of the Innovation Ecosystem: Taiwan's A-Team acts as an industrial platform in the innovation ecosystem in Taiwan. When manufacturers cooperate with suppliers in an industrial platform, suppliers can act in supporting roles. The division of labor can be performed in three methods in the cooperation between manufacturers and suppliers. First, manufacturers can ask suppliers to make their products exclusively. Second, manufacturers can collaborate with suppliers to jointly develop products based on standards. Third, manufacturers can procure products directly from the supplier's catalog.

In the first and second methods of the division of labor between manufacturers and suppliers, suppliers will follow the established standards to offer products. In the example of SRAM, 70% of SRAM's products adopt the first and second methods for division of labor. For example, if SRAM lacks the know-how for some products, such as flywheels, they will seek the manufacturer's cooperation in the process of cooperative development.

In the example of FSA, FSA adopts the second method of cooperative development, since its customers are global leading companies. Initially, FSA provides customers with a product catalog for an in-depth understanding of its products. FSA and its customers communicate to focus on how to match between FSA and its customers according to its customers' needs.

In the example of Merida, 90% of Merida's products adopt the third method. Merida introduces 500 models of bicycles into the market every year under its own brand and as an OEM. A consensus has been reached between Merida and its suppliers for long-term cooperation, so Merida can procure products from the existing catalogs.

In Taiwan's bicycle industry innovation ecosystem, the core manufacturers join with the suppliers to act as an industrial platform. Generally speaking, 90% of standard products can adopt the third method of procurement from the existing catalogs, and 10% of innovation products adopt the second method of manufacturers collaborating with suppliers to jointly develop products.

One important reason behind the establishment of Taiwan's A-Team was a strong awareness of the challenges and risks faced by the industry. It was the strong commitment and shared vision of the two manufacturers Giant and Merida that laid the foundation of the A-Team's successful development in terms of operating mechanisms and learning mechanisms. The degree of complementariness among bicycle manufacturers in the market is currently greater than the degree of competitiveness, which should help some activities, such as comarketing, to proceed.

B. Theoretical Implications

Taiwan's A-Team was started from the supply chains of companies. Because of A-Team, the companies tried to compete and coexist constructively within the innovation ecosystem. There are four theoretical implications of the innovation ecosystems in this article.

1) Industrial standardization is required when joining A-Team. Faced with low-price competition from China and other countries, A-Team transformed its crisis into an innovation ecosystem, while defining the goal of coexistence and common prosperity in the bicycle industry. The members of A-Team cover multiple manufacturers and suppliers. The goal of A-Team is to enhance the competitiveness of the entire industry. Although information sharing is the basis for industrial standardization, it does not mean that all information must be disclosed.
2) A-Team plays the role of an industrial platform, which can function as a group of innovative assets for developing information, technology, and production to provide high value-added products and services. A-Team serves as an industrial platform to facilitate the establishment of the innovation ecosystem. A-Team performs an integrated function, similar to a platform, to seek the sharing and the use of partnerships and complementary assets in the innovation ecosystem. In this article, we contributed to the rich theoretical implications by showing the platform effect of A-Team.
3) The complementors in an innovation ecosystem increase the external effects of the networks effects. A-Team brings together domestic and foreign complementors to create an external network effect for the entire industry. For example, the complementors of components companies such as SRAM and Shimano have joined A-Team to generate external network effects and contribute to high value-added

products in Taiwan's bicycle industry. A-Team not only enhances the overall competitiveness of Taiwan's bicycle industry but also contributes to product differentiation in companies.

4) A-Team not only assists the members in working with each other but also joining with the industrial platform and the complementors to gain the advantages of product differentiation. A-Team also promotes competition among members to provide high value-added products in the innovation ecosystem.

C. Practical Implications

In order to respond to low-price competition from China and other countries, A-Team members collaborate and compete with each other. A-Team contributes to the increase of added value in Taiwan's bicycle industry. Taiwan's bicycle industry A-team is a symbol of positive change and upgrade for Taiwanese industry and an example of the innovation ecosystem coping with globalization and liberalization in a knowledge-based economy. As a new model for Taiwanese manufacturing, it may also offer hope for catching up to, or possibly even surpassing, competition from advanced economies. Taiwanese companies must work to strengthen their ability to identify market trends and move towards both ends of Stan Shih's "smiling curve" of industry profitability. In Stan Shih's "smiling curve" concept, companies from the right side of the smiling curve (e.g., brands companies) outsource services to companies on the left side of the smiling curve (e.g., R&D and manufacturing companies) [32].

Overall, an innovation ecosystem is significant for practical implications due to the following four reasons.

1) An innovation ecosystem tends to display a multicentered network structure. Members of an innovation ecosystem also tend to display a strong desire to learn. Innovation ecosystems typically require a stable set of members and may represent the most promising development path for Taiwan's companies.
2) As proven by Taiwan's bicycle industry A-team, innovation ecosystems lay to rest the traditional myth that Taiwanese companies in the same industry cannot cooperate or coinnovate. It seems likely that other industries may also be able to benefit from the structure of an innovation ecosystem, while the case discussed in this article applies only to a single industry.
3) Through integrated coinnovation, Taiwanese companies can work together to establish comprehensive product solutions by utilizing interactive communication and coordination among the members in the innovation ecosystem. While integrated solutions can be difficult to achieve, they may well present a new path for cooperation between industry and academia.
4) The process of coinnovation reflects the importance of pursuing long-term dynamic learning efficiencies in organizations. It seems clear that long-term relationships do not guarantee supplier profits and dependency ultimately interferes with learning. Moreover, because product value is ultimately a subjective judgment of individual consumers, some types of "closed" organizational structures will definitely face obstacles. High levels of trust and independent capabilities are essential. It would appear that the A-Team structure has been able to support learning in the innovation ecosystem.

Going forward, industrial standardization and coinnovation will be very important for innovation ecosystems in Taiwan. An innovation ecosystem is less easily copied and so presents the possibility of more differentiated and therefore more sustainable competitive advantages. The concept of the innovation ecosystem and coinnovation is very helpful for practitioners interested in the upgrading and reformation of the entire industry in Taiwan. By providing a vision for the innovation ecosystem in Taiwan, coinnovation may be an indispensable concept for the future of manufacturing worldwide.

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