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Sustaining Higher Education Quality by Building an Educational Innovation Ecosystem in China—Policies, Implementations and Effects

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Abstract: This article analyzes how China has worked to develop and build a higher education innovation ecosystem in the past decade. Binding its analysis to three types of data, namely clusters of national policies issued by important Chinese government bodies, dozens of articles in an internal journal of the Ministry of Education, and various Chinese media accounts, the article unravels how resources are mobilized and the direction chartered for unprecedented engagement between different stakeholders for education purposes. The findings reveal that the establishment of a higher education innovation ecosystem derives from the need to improve the overall higher education quality in full swing and has been realized as a strategic consensus among the government, enterprises, higher education, and social forces. The ecosystem is underpinned by the assigning of different roles to different stakeholders based on collaboration and division of labor. At the same time, there is also substantive capital, resource mobility, and the infusion of industrial technological expertise underpinning such an innovation ecosystem that involves six categories of collaboration at macro and micro levels. The impact of the higher education innovation ecosystem thus far includes deepened and extensive participation in higher education quality improvement by multiple types of stakeholders and the same type of stakeholders across different tiers. Instructors' teaching and students' learning have experienced changes due to the ecosystem's impact at a micro level, and many institutions have increased shared governance practices to better cater to the synergy among different sides. At the same time, there is an unevenness in the innovation ecosystem in terms of participating higher education institutions and enterprises.

Keywords: educational innovation ecosystem; higher education; education sustainability; university-industry collaboration; Chinese higher education

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1. Introduction

As the 21st century continues to undertake a new round of technological and industrial revolution with the deepening of Industry 4.0, the world demand for competent application-oriented manpower and high-quality talents has increased at an unparalleled pace and scale [1–3]. Against such a backdrop, higher education institutions are highly expected to update their education quality as professional organizations responsible for the provision of such quality manpower and talents. The reality, however, is that there has been considerable public concern over higher education quality on the part of both higher education institutions themselves and other stakeholders, such as the government, the industry sector, and other non-governmental social forces. Many national governments around the world are concerned about whether their societies will be refilled ceaselessly with sufficient competent university graduates and manpower to sustain economic growth and meet social challenges. Industrial insiders, at the same time, are perplexed about the gap between the university provision and industrial needs, namely not being able to recruit

those university graduates who fully have the technical and professional skills needed in the workplace [4]. Other social stakeholders (e.g., parents) are beset by other issues that affect university students' growth and development, such as the escalation of education costs, credentialization of higher education, unemployment issues, and so forth [5]. The interest in university education quality and higher education sustainability has not faded, but on the contrary, even resurged as scientific and technological revolutions of the world continue to scale greater heights.

Despite the fact that higher education quality is affected by various factors, such as the massification of the sector itself, an unsatisfied faculty-student ratio, insufficient education facilities, or the pro-research evaluation mechanism for faculty members [6,7], the limited exposure of faculty members to authentic industrial experiences, the insufficient existence of state-of-the-art expertise from the industry, and the lack of an educational innovation ecosystem where different stakeholders collectively infuse higher education sector with their respective strengths have been increasingly recognized as factors hindering the improvement of higher education quality over the years [4,8–10]. As such, university-industry collaboration under the coordination and auspices of the government has been commonly perceived as an effective way to resolve the gap between university education provision and the real graduate attributes needed by society in the past decade [11–13].

It is worth noting that a large proportion of the current university-industry collaboration worldwide lies in research collaboration and technology transfer [14] under the currently prevalent interaction framework between the government, universities, and the industry sector, with teaching or education-focused collaboration practiced to a much lesser extent [15]. When it comes to the innovation ecosystem that involves the synergy between various stakeholders, the goal is mostly focused on non-education aspects. While these research collaborations do provide benefits for both sides, such as the commercialization of university-based technologies for financial gains, enhancing technological capacity and economic competitiveness for companies, and access to research networks or precursors to other collaborations [14,16], the extent to which state-of-the-art technology taking place in the industrial sector is exposed by university students is limited. In other words, the long-standing systematic and structural university-industry gaps are not well addressed by these research-focused collaborations. As such, in many parts of the world, government, academia, and the industry sectors are still beset with how to enable universities to cultivate talents that can effectively and efficiently meet industrial demands to maximize economic competitiveness in the knowledge economy. The root cause of such a problem lies in the lack of a stable, sustainable, and effective education-focused innovation ecosystem as opposed to one that focuses on other aspects such as research.

Research has identified various preconditions for inter-organizational collaborations, such as necessity, reciprocity, efficiency, stability, legitimacy, asymmetry, etc. [16]. As different types of organizations, government bodies, higher education institutions, and companies from the industry sector, despite their recognition of the prominence of collaboration for education purposes, often find it difficult to match their goals, interest pursuits, and operation habitus in collaboration for a given project. Their incentives for substantive collaborative education are therefore limited. For instance, companies have the nature to pursue short-term economic returns and the tendency to train personnel with a highly concentrated focus., but such training would be difficult if that personnel, especially new recruits, do not have a solid theoretical foundation on campus, as those trained would not be able to understand the rationale of the state-of-the-art technology [17]. On the other hand, without exposure to authentic project cases, students not only have difficulty understanding the theories learned due to their high degree of abstraction and the de-contextualized learning approach, but also cannot make of the skills needed in authentic workplace settings [4,18]. The government, however, has to strike and keep a balance between endeavors that have long-term social yields and short and medium-term innovations which are more focused on economic returns. As such, how to build an effective educational innovation ecosystem to ensure that different types of stakeholders deeply understand each other's

demands and concerns, afforded by effective resource input, policy guidance, and incentive mechanism to offset the innate divergences across sectors, is crucial in yielding stable and effective education-focused collaboration that maintains higher education quality.

In recent years, China has gone to great lengths to distribute policy mechanisms to coordinate between the higher education sector and the industry sector for collaborative education, with building a sustainable higher education sector constituting a major agenda for the Chinese government. Such sustainability is perceived to be underpinned by the high degree of synergy between the higher education sector and other important stakeholders in scaling greater heights in the overall teaching and education quality and enabling higher education to be more responsive to industrial and societal demands. To achieve such sustainability, relevant policies have been issued not only by China's Ministry of Education (MOE), which is especially responsible for education affairs throughout the country but also by other important state-level bodies such as the State Council, the Ministry of Finance, the Chinese Academy of Engineering to forge synergy for the university-industry collaborative education. Platforms are specially provided biannually for enterprises and universities to understand each other's demands and strengths and identify appropriate partners. The initial yields in mobilizing resources and fostering synergy in enhancing university education quality have been salient. Enterprises have been largely motivated to engage in universities' education reform, including reform to teaching patterns, course structure, and other stages of student learning. Over the several years, the number of enterprises participating in education-focused university-industry collaboration soared from 15 only in 2015 to 501 in 2020. Involved collaborative projects burgeoned from 243 in 2015 to 16,717 in 2020, and business investment in such collaborations increased from 17 million RMB in 2015 to 559 million RMB in 2020 [19]. Furthermore, the government bodies, enterprises, and higher education institutions involved are comprehensive across tiers and levels. Not only premier universities, world-renowned enterprises, and national governmental departments are taking an active part in fueling the collaborative education projects, but so are ordinary higher education institutions, less known enterprises, and local governments as well.

Despite the fact that sustainability has recently emerged to constitute an important theme in the global literature on higher education [20–22], most of the existing studies on this topic derive from the Western context, especially the European context. Few studies have probed into the development of the sustainable higher education sector in the Chinese context where the education system has a different landscape and the practices for developing sustainable higher education have their unique features. Given such a research gap, this study therefore binds its analysis to the policies, implementation, and effects of China's attempts to build a multiple stakeholders-underpinned and synergy-oriented sustainable higher education sector in the most recent years. Specifically, the study will answer three research questions: (1) Why does China want to develop a sustainable higher education sector? (2) How can a sustainable higher education sector be achieved? (3) What is the preliminary impact of China's effort thus far?

2. Sustainable Entrepreneurial University (SEU) as a Conceptual Framework

Contemporary higher education reforms in the global higher education community have been premised upon the assumption that higher education institutions are no longer supposed to be the ivory towers where time elapses at a leisured pace for academics' unhurried contemplations. Rather, higher education institutions are expected to be more socially responsible, fuel social innovation, cater more to industrial demands, and support sustainable development at large [23,24]. The SEU has been recently conceptualized as an ideal type of university to embody the new societal engagement roles expected of higher education institutions [20]. SEUs are socially responsive entities that co-create sustainability in collaboration with other stakeholders by incorporating social, ethical, and environmental principles and values within their main functions and becoming key agents in optimizing the regional institutional environment [25,26]. SEUs' roles, to be noted, are beyond the

narrowed scope of promoting economic growth but involve much broader engagement for social transformation.

Cai and Ahmad point out that compared with ivory-tower universities or traditionally defined entrepreneurial universities, SEUs take on new features in terms of teaching, research, societal engagement, organization and administration, knowledge flow, interactions with innovation actors, and university and society relations [20]. Specifically, SEUs shift the role from technology transfer to knowledge co-creation and carry out societal engagement in global terms. With an aim to serve society's current demands and shapes its future, SEUs not only institutionalize interdisciplinary collaboration and university networks as new sources of administration but also go to great lengths to reconcile both entrepreneurial and sustainability mindsets on course to driving societal changes. Rather than being knowledge producers on their own, SEUs more often than not work as anchor organizations for knowledge exchange where creativity, invention, and innovation across disciplines and sectors are triggered by the intensified interaction of people, culture, and technology. For this goal, building trust among collaborators in innovation ecosystems is also a core feature of SEUs in that the actors involved in the innovation system are more diverse, hence the necessity of trust in realizing the value of weak ties and diffusing innovation. Moreover, SEUs seek to shape a better future society through transforming society at large rather than just meeting the needs for economic development.

In this article, we draw upon the concept of the SEU to express a situated uptake of the innovation ecosystem in the context of Chinese higher education and to discuss the preliminary impact of China's reform efforts thus far. Although Cai and Ahmand argue that there might be no universities that can meet all the features of an SEU in reality [20], this concept can signal the direction of a Chinese approach to creating synergistic relationships and set the standards against which the goals and objectives in China's educational development at postsecondary level can be benchmarked. This concept also sheds light upon the way in which resources, capital, and expertise are mobilized to form mutual support among the government, enterprises, higher education institutions, and social forces for a win-win educational outcome.

3. Methodology: Content Analysis

The study employs content analysis of the policies and implementation of China's attempts to build a higher education innovation ecosystem. The data are derived from three types of sources. The first type of data is the clusters of policies per se, with the aim to unravel how the Chinese government has mobilized resources and charted the direction for deeper engagement between companies and higher education institutions. More than a dozen policies issued by the State Council, important ministries, and departments over the past five years are included for analysis. From such policy clusters, a comprehensive view of policy intents regarding the establishment of higher education innovation ecosystem will be obtained. Policy themes include national efforts to deepen the industry-education integration, developing a broad range of application-oriented disciplines such as New Engineering Education, Emerging Agricultural Education, New Medical Education, and New Humanities Education.

The second type of data is an internal journal specifically covering university-industry collaborative education issued by China's MOE. Unlike other academic journals, this internal journal is highly practice-oriented, encapsulating a large number of authentic practices and implementations between the industry and the higher education sector in co-developing talent skills that cater to industrial demands, and serving the purpose of informing policymakers of the areas in which improvements should be made of the initiative. The contents analyzed from this source include the remarks of MOE leaders and the overall landscape of university-industry educational collaboration over the past few years and typical university and industry cases of praxis in several important areas, such as manpower cultivation pattern reform, course structure, and system reform, university

teaching reform, enterprises' innovation in engaging with universities, and promotion of regional economic development.

The third type of data is derived from media accounts on the practices, effectiveness, and problems regarding collaborative education and the education innovation ecosystem at large. Here different perspectives and reflections on the implementation of relevant policies can be gained. For example, MOE has built a special platform for university-industry collaboration where all participating enterprises' information can be found, and many practitioners share their specific cases of collaborating with universities. The special online platform of university-industry collaboration comprises various sub-columns such as the communication and partnership conferences by universities and companies, business requirements and guidelines on collaborating with universities, excellent and exemplary collaboration, and ecosystem development cases. Thousands of participating enterprises' guidelines on the collaboration are listed on this platform. Furthermore, one of the leading and most influential domestic media Global Times has opened up a special section on China's university-industry collaboration and the development of the innovation ecosystem. Other media accounts include online newspaper articles, academic essays, and online opinion pieces that present professional comments and reflections on the implementation of the innovation ecosystem development. These media accounts are good sources to obtain Chinese responses to and reflections on this study's research topic.

Tables 1 and 2 outline the specific policy documents, contents of the MOE's internal journal, and media accounts selected for data analysis. The research method for the three types of data included interpretation for the purpose of meaning extraction, understanding seeking, and knowledge presentation [27,28].

Table 1. Policies included in building the higher education innovation ecosystem.

No.	Year	Issuing Unit	Policy	Source
1	2015	State Council	On Deepening Innovation and Entrepreneurship Education Reform	http://www.gov.cn/zhengce/content/2015-05/13/content_9740.htm (accessed on 12 February 2022)
2	2017	State Council	On Deepening Industry-education Integration	http://www.gov.cn/zhengce/content/2017-12/19/content_5248564.htm (accessed on 12 February 2022)
3	2017	MOE	New Engineering Education State 1—'Fudan Consensus'	http://www.moe.gov.cn/s78/A08/moe_745/201702/t20170223_297122.html (accessed on 12 February 2022)
4	2017	MOE	New Engineering Education State 2—'Tianda Action'	http://www.moe.gov.cn/s78/A08/moe_745/201704/t20170412_302427.html (accessed on 12 February 2022)
5	2017	MOE	New Engineering Education State 3—'Beijing Compass'	http://news.sciencenet.cn/htmlnews/2017/6/379053.shtm (accessed on 12 February 2022)
6	2017	MOE	Notifications on Carrying out New Engineering Education Research and Practice	http://www.moe.gov.cn/s78/A08/tongzhi/201702/t20170223_297158.html (accessed on 12 February 2022)
7	2017	MOE	Notifications on Recommending New Engineering Education Research and Practice Projects	http://www.moe.gov.cn/srcsite/A08/s7056/201707/t20170703_308464.html (accessed on 12 February 2022)
8	2018	MOE, MII, CAE	On Accelerating the Development of New Engineering Education for the Cultivation of Extraordinary Engineers (Plan 2.0)	http://www.moe.gov.cn/srcsite/A08/moe_742/s3860/201810/t20181017_351890.html (accessed on 12 February 2022)
9	2018	MOE	On Accelerating the Development of High-quality Undergraduate Education and Enhancing the Quality of Talent Cultivation in Full Swing	http://www.moe.gov.cn/srcsite/A08/s7056/201810/t20181017_351887.html (accessed on 12 February 2022)
10	2019	MOE	Emerging Agricultural Education State 1—'Anji Consensus'	http://news.cau.edu.cn/art/2019/6/29/art_8779_626286.html (accessed on 12 February 2022)
11	2019	MOE	Emerging Agricultural Education State 2—'Beidacang Action'	http://www.moe.gov.cn/jyb_xwfb/s5147/201909/t20190923_400289.html (accessed on 12 February 2022)
12	2019	MOE	Emerging Agricultural Education State 3—'Beijing Guide'	http://www.centv.cn/p/343210.html (accessed on 12 February 2022)
13	2020	State Council	On Accelerating the Innovation of Medical Education	http://www.gov.cn/zhengce/content/2020-09/23/content_5546373.htm (accessed on 12 February 2022)

Table 1. *Cont.*

No.	Year	Issuing Unit	Policy	Source
14	2020	MOE	Announcement on Initiating New Humanities Education	http://www.moe.gov.cn/jyb_xwfb/gzdt_gzdt/s5987/202011/t20201103_498067.html (accessed on 12 February 2022)
15	2020	MOE	University-Industry Collaborative Education Program Notification by Ministry of Education	http://www.moe.gov.cn/srcsite/A08/s7056/202001/t20200120_416153.html (accessed on 12 February 2022)
16	2020	MOE	Notification on Soliciting University-industry Collaborative Education Projects in 2020 by the Ministry of Education	http://www.moe.gov.cn/s78/A08/tongzhi/202005/t20200529_460209.html (accessed on 12 February 2022)

Table 2. Contents Analyzed from the MOE Internal Journal.

No.	Title	Author	Author Positions	Page
1	Remarks on New Engineering Education Peking University International Conference	Wu Yan	Head of Department of Higher Education, MOE	1–2
2	Progress and Reflections of China's Higher Education–Industry Collaborative Education	Xu Xiaofei et al.	Expert Panel Members of MOE's University-industry Collaborative Education, University Representatives	3–10
3	Data on MOE's University-industry Collaborative Education (2015–2020)	Shi Yang et al.	Expert Panel Members of MOE's University-industry Collaborative Education, University Representatives, Company Representatives	11–17
4	"Two Cross-disciplines and Four Integration": Jingying Extraordinary Engineering Education Talent Cultivation Pattern	Zheng Qinghua	Participating University Representative from Xi'an Jiaotong University	18–23
5	Engineering University-oriented University-industry Collaborative Education Pattern	Zhou Zhipeng et al.	Participating University Representative from Nanjing University of Aeronautics and Astronautics	24–29
6	Hot Spots of China's University-industry Collaborative Education	Yang Lihai et al.	Participating University and Company Representatives from Henan Polytechnic University and Shenzhen Aoya Design Co. Ltd.	30–37
7	Bottlenecks and Solutions to University Work against the Backdrop of "Revitalizing Northeast China + University-industry Collaboration": Dalian City as an Example	Wu Di & Shi Hui	Participating University Representative from Dalian University of Technology and Liaoning Normal University	38–41
8	Reforms to the Synergy and Innovation Mechanism for Application and Industry-oriented Higher Education Institutions	Zhou Li et al.	Participating University Representative from Beijing Wuzi University and Capital University of Economics and Businesses	42–47
9	Reform to the Teaching of Customer Experience Design against the Backdrop of New Engineering Education: Based on Four Integrations	Zhao Tianjiao et al.	Participating University and Company Representatives from Tianjin University and Nanjing Qianxue Education Technology Co. Ltd.	48–54
10	Exploration and Practices of University and Industry Collaborative Education-oriented Course Development	Dai Xiao'ai et al.	Participating University and Company Representatives from Chengdu University of Technology and Beijing Hangtian Hongtu Information Technology Co. Ltd.	55–60
11	University-industry Collaboration-based Development of Computer Science at Universities of Western China	Zhu Lei et al.	Participating University and Company Representatives from Xi'an University of Technology and Shenzhen Tecent Computer System Co. Ltd.	61–67
12	PBL-based Engineering Ethics Education for Traffic Engineering Programs	Li Yingshuai & Wang Weijie	Participating University Representative from Nanjing University of Technology	68–72
13	Exploration and Practices of Talent Cultivation based upon University-industry Collaboration	Zeng Xianqun et al.	Participating University and Company Representatives from Donguan University of Technology and Beijing Wenhua Online Education Co. Ltd.	73–77
14	Practical Exploration of University-industry Collaborative Education against the Backdrop of Technology Iteration	Wang Zanshe et al.	Participating University and Company Representatives from Xi'an Jiaotong University, Xi'an University of Architecture and Technology, and Xianyang Jingwei Fucha Co. Ltd.	78–81
15	Patterns of Cultivation of Innovative Talents in the Field of Automation based on University-industry Collaboration	Zhang Lanyong et al.	Participating University Representative from Harbin Engineering University	82–86
16	Practice and Exploration of University-industry Collaborative Education for the Field of Digital Media and Arts	Jing Fei	Participating University Representative from Nanjing University of Technology	87–89

Table 2. *Cont.*

No.	Title	Author	Author Positions	Page
17	Project-based Multiple-dimension University-industry Integrative and Collaborative Education: AI Programs as Examples	Zhou Xue	Participating University Representative from University of Electronic Science and Technology of China	90–93
18	Innovation of University-led Collaborative Education with the Industry: Example of Developing Rhizoma Bletillae Glucomannan Mucosal Repair Factor	Guan Li et al.	Participating University Representative from Xi'an Medical College	94–96
19	University-industry Collaboration in Developing New Engineering, Agriculture, Medicine and Humanities Education	Cheng Huan	Participating Company Representative from Beijing Chinasoft International	97–103
20	Cloud-based Cultivation of New Engineers	Liu Xiangwen et al.	Participating Company Representative from Ali Cloud Computation Company	104–110
21	Establishing Effective Patterns for Key Fundamental Software Talents	He Shu et al.	Participating Company Representative from Qilin Software Co. Ltd.	111–115
22	Developing Digital Manpower for the New Times based on Industry-education Integration	Huike Group	Participating Company Representative from Huike Group	116–121
23	Exemplary Cases for Promoting University-industry Collaborative Education via a Win-win Pattern: Example from Cross-boarder E-commerce Cases	Gao Gongbu et al.	Participating University and Company Representatives from Yangzhou University and Kaiyuan E-commerce (Shenzhen) Co. Ltd.	122–127

4. Results

A content analysis of the data reveals that the attempts to establish and maintain a higher education innovation ecosystem in the past few years result from China's intention to promote its overall higher education quality to a higher level, and such an endeavor has been realized as a strategic consensus among the government, enterprises, higher education sector, and other social forces. There is substantive capital and resource mobility underpinning such an innovation ecosystem, as opposed to mere calls or slogans. Multiple types of stakeholders, as well as the same type of stakeholder across different tiers, have been involved in the collective creation of the innovation ecosystem in a synergistic and concurrent manner, and the innovation in higher education takes place at both the macro policy level and micro course level on the part of university education. At the same time, there are also reflections of the advancement of the education innovation ecosystem among Chinese academia and media outlets.

4.1. Question 1: Why Establishing a Sustainable Higher Education Sector?

4.1.1. Quality Improvement as the Rationale

Our data analysis reveals that improving the overall higher education quality and building up a quality culture constitute the original impetus for developing a higher education innovation ecosystem in China in the first place. Across the 16 governmental documents we analyzed as shown in Table 1, quality (质量 , zhi liang) in relation to teaching and learning, talent cultivation, and other aspects of higher education is a high-frequency word appearing many times to emphasize the telos of the operation of the Chinese higher education. In the Chinese language, a core conception such as quality is often expressed together with either an adjective or a noun to signal the desired state of the conception or the expected aspect where the conception should play a role, and therefore there are a variety of lexical ways for a conception to be manifest. In our case, quality is jointly used with phrases to denote the heights that higher education is expected to scale or the facets where higher education should better meet people's demands. Examples include human resource quality (人力资源质量 , ren li zi yuan zhi liang), education, teaching and learning quality (教育教学质量 , jiao yu jiao xue zhi liang), higher quality (更高质量 , geng gao zhi liang), new quality (新质量 , xin zhi liang), and so forth. Table 3 summarizes the manifestations of the word quality across the 16 official documents analyzed, from which it can be seen that quality appears a total of 109 times in various forms. Among all, talent cultivation quality and teaching and learning quality top the list of frequency of appearance. At the same time, a wide range of aspects is expected to be filled with strong quality elements, such as students' employability, faculty training, textbook development,

capstone project completion, program development, overall graduate attributes, and so on. The means through which goals are to be realized also include a variety of respects, such as developing and maintaining quality culture, quality assurance mechanisms, quality standards, etc.

Table 3. Quality-related Phrases across the 16 Sampler Official Policy Documents.

No.	Chinese Phrase	English Translation	Frequency
1	高质量	high quality	7
2	高等教育质量	higher education quality	5
3	人才培养质量	talent cultivation quality	16
4	教学质量	teaching and learning quality	15
5	教育质量	education quality	6
6	就业质量	employment quality	4
7	质量	quality	6
8	人力资源质量	human resource quality	1
9	新质量	new quality	5
10	质量文化	quality culture	7
11	专业质量	program quality	3
12	毕业生质量	graduate quality	1
13	质量提升	quality improvement	1
14	质量评价	quality evaluation	5
15	质量标准	quality standard	4
16	工作质量	work quality	3
17	毕业设计质量	capstone project quality	1
18	教材编写质量	textbook development quality	1
19	质量保障	quality assurance	9
20	质量监测	quality monitoring	3
21	质量革命	quality revolution	3
22	质量中国	quality China	1
23	生源质量	new student quality	1
24	住培基地质量	training base quality	1
	Total		109

As can be seen, quality improvement, on top of previous standards, has taken up the dominant theme of China's higher education discourses over the past few years. It also works as a strong impetus for China to build a higher education innovation ecosystem, out of the need to address quality concerns and resolve quality problems.

4.1.2. The Need for Building a Higher Education Innovation Ecosystem

Apart from the frequent appearance of quality-related lexical resources across the 16 governmental documents, quality also shows up considerably in our second type of data, namely dozens of articulations by various non-government actors, as shown in Table 2. As such, the development of a higher education innovation ecosystem is not just proposed and propelled by the Chinese government but is a strategic consensus realized among many different types of important stakeholders of higher education. In the past eight years, the State Council, being China's top administrative body, as well as important governmental departments such as the Ministry of Education and the Ministry of

Industry and Information, participating enterprises from the industrial sector, and scholars from academia, all now have a consensus on the importance of building an innovation ecosystem of higher education featuring a high degree of cross-sector and cross-disciplinary collaboration, synergy, integration, and cooperation, if China's higher education quality is to scale greater heights. Two aspects are worth noting regarding such a consensus on the higher education innovation ecosystem. Firstly, such a consensus goes beyond the rationale of China's national effort to build world-class universities or disciplines, as revealed in much current scholarship [29], because it involves a variety of stakeholders across different sectors and tiers in full swing. Secondly, this ecosystem is highly education-focused, rather than focusing on other aspects of cross-sector collaboration (e.g., research), which has been going on for a long time.

"Integration", "ecosystem", and "innovation" are also high-frequency phrases across many policies issued between 2015 and 2020. For instance, as early as seven years ago, out of the need to grow the small and medium-sized private economy and further resolve employment issues by encouraging more graduates to start their own businesses, entrepreneurship education was accentuated against the larger economic backdrop. However, the government started to signal a message that university graduates' competence, including entrepreneurship competence, should be catered to by the industrial sector with authentic industrial expertise. As such, the policy document On Deepening Innovation and Entrepreneurship Education Reform issued by the State Council that year called for universities to make use of all possible resources in and outside the higher education sector and called for society to provide collective care and support for universities' entrepreneurship education advancement (Policy No. 1, Table 1).

Not long afterward, in 2017, the State Council issued another important guiding document on deepening industry-education integration. The stipulation of this document is derived from the gap between the provision of graduates on the university side and the demand for high-caliber application-oriented talents on the market side. Facilitating university-industry collaborative education and promoting the structural reform of the supply mechanisms for manpower constituted the central concern of the government agenda. In this particular document, it writes that all stakeholders involved should "develop and complete an innovation ecosystem where higher education institutions highly collaborate with major enterprises, small and medium-sized enterprises to augment the competence to cultivate higher-caliber talents, upgrade industrial capacity, ... based on a network of industry-education integration featured by smooth order, functional complementarity, resource sharing, and close collaboration" (Policy No. 2, Table 1).

The innovation ecosystem is not limited to only a few individual disciplines but is afforded by the development in a broad range of important areas. The "Four New" Project, which literally refers to "New Engineering Education", "Emerging Agricultural Education", "New Medical Education", and "New Humanities Education", are special national projects in recent years to underpin the development of the higher education innovation ecosystem. As can be seen from the title and contents of the policy documents shown in Table 1, the development of the "Four New" Project is featured by unprecedented enterprises' participation in course reform, teaching reform, and other aspects of reforms to higher education quality on the university side (Policy No. 3–8, No. 10–14, Table 1). The rationale for these national strategies is that against the global backdrop of Industry 4.0 and Biomedicine 3.0, China, as a developing country and an emerging economy, especially needs a broad range of skilled workers and innovators with expertise in these key areas for the transition to a knowledge-based and innovation-driven economy. For all of the four areas to achieve better results in cultivating talents, China understands that the measures it needs to take should be a complete overhaul of its existing education patterns instead of tinkering with superficial changes. Given the long-standing university-industry gap and sparse awareness of authentic workplace settings by university faculty and students, which applies to different disciplines and areas, forces outside the higher education domain

are conceptualized as prominent facilitators for the overall manpower provision to scale greater heights.

4.2. Question 2: How Can the Sustainable Higher Education Sector Be Achieved?

4.2.1. Roles of Different Stakeholders Based on Collaboration and Division of Labor

According to the three types of data collected, the higher education innovation ecosystem is based upon both collaboration and division of labor in terms of different stakeholders' distinctive roles. On the one hand, coordination and close ties are expected of government bodies, enterprises, universities and colleges, and non-governmental industrial associations as social forces. As outlined above, there is a strong consensus among different stakeholders pertaining to the necessity of developing a higher education innovation ecosystem. On the other hand, different stakeholders are expected to support each other with the ultimate purpose of upgrading higher education quality.

Specifically, contrary to a lot of literature that portrays the Chinese government as the grand boss that controls everything, the government's role in this new round of discourse is stipulated as more of a supporter and coordinator that fuels enterprises to be actively engaged with university education affairs and builds up open platforms for universities and the industry sector to find appropriate partners. Not only education-related ministries (e.g., MOE) are supposed to provide favorable policies for industrial associations and enterprises to participate in various educational activities on campus, but other non-education-related governmental departments (e.g., Ministry of Finance) are also required to provide financial incentives to ensure that all parties are motivated to work towards the goal of educational collaboration (Policy No. 2, Table 1).

Enterprises, at the same time, are accorded the main role in assisting higher education institutions to improve education contents and methods as they are believed to stand at the technological forefront (Policy No. 2, Table 1). It fully recognizes the educational subjectivity of enterprises apart from that of universities and colleges in ensuring higher education quality, while still acknowledging enterprises' innate nature to pursue profits and short-term economic returns. Outputting their technological expertise to higher education institutions, among others, is an important expectation of enterprises to play their role in fueling Chinese university education quality.

Universities and colleges themselves, unsurprisingly, are expected to undertake the main-actor role as well. They are required to carefully research several extremely prominent aspects perceived to impinge upon the education quality at the end of the day, including demands of industry, technological forefronts, students' new ways of learning and interest in learning, a scientific accountability mechanism, international disciplinary frontiers (Policy No. 4, Table 1). To be more specific, engineering-savvy universities and colleges ought to develop new programs catering to emerging technologies, upgrade the contents of existing programs to keep up with the times, and develop more cross-disciplinary and problem and project-based engineering course modules that are more liable to cultivate innovative students. National comprehensive universities are expected to achieve breakthroughs in basic research and foster new areas of revolutionary innovation based upon comprehensive disciplinary and cross-disciplinary strengths. Local institutions of higher learning are expected to further strengthen a few major areas to cultivate application-oriented talents to serve local economic development. Cultivating students' praxis competence is highly prioritized in their overall agenda (Policy No. 3, Table 1).

Other social forces, such as industrial associations, foundations, and reputative celebrities, are expected to help bridge the gap between the provision of university education and the demands on the side of the industry and provide funds for the operation of the innovation ecosystem (Policy No. 2, Table 1; Articles from Table 2).

4.2.2. Capital Flow and Resource Mobility Propping up the Higher Education Sustainability

It warrants a mention that the progress of the higher education innovation ecosystem over the past few years in China has been made by no means through policy intents alone

but has been underpinned by substantive capital flow and resource mobility according to our content analysis. For instance, the State Council documents mentioned above explicitly advocates favorable conditions for enterprises that provide support to universities and colleges regarding their education improvement. These favorable conditions for the industrial sector include but are not limited to tax reduction, economic compensation, financial support, and so forth. Examples include policy statements such as "various levels of fiscal and tax departments ought to take structural tax-reduction measures for companies which take an active part in deepening the university–industry collaboration in education" (Policy No. 2, Table 1). Moreover, enterprises that are providing substantive support to collaborative education are entitled to reduced tax burden and even favorable prices for purchasing resources (e.g., land) for their business development. The government bodies required to form the synergy for such ecosystem advancement, according to the State Council policies, go beyond merely educational departments, but also include a broad range of ministries in other sectors, such as the Ministry of Finance, the Ministry of Land and Resources, State Development and Reform Commission, and so forth.

However, the direction of the resource mobility is not from the government to enterprises only. On the special platform for the university-industry collaboration established by MOE, which belongs to the third type of data analyzed, thousands of enterprises have listed their schemes and plans regarding how they would collaborate with higher education institutions across disciplines. As can be seen, for every collaborative project having been established or to be established, participating enterprises offer at least 50,000 or 100,000 RMB (roughly 7000 or 14,000 Euro) depending upon the category of the project. An enterprise usually joins universities and colleges to develop dozens of collaborative educational projects (e.g., course development, practical education, faculty training) per phase, which means contributions to higher education institutions worth more than a million RMB for each individual enterprise. For those well-resourced big names such as Alibaba, they support more than 100 such projects during every phase of collaboration, which amounts to more than 10 million RMB capital flow from the enterprise to the university-industry collaboration projects.

Through the content analysis of the second type of data, namely the numerous cases shown in the internal journal, there are at least three types of benefits enterprises can gain through engaging in the university-industry collaborative education: enhancement of brand name, acquisition of economic returns, and open up new business areas. Firstly, as can be revealed from the third type of data, especially the special MOE platform on university-industry collaboration, every participating enterprise is openly listed and known to the general public as a higher education reform facilitator. As of 2021, a total of 1059 enterprises have disseminated their strengths, features, values, and competitiveness through this platform and other media reports because of their collaboration with relevant universities or colleges in promoting talent cultivation. The advertising effects and halo effects have been pronounced despite their cost in supporting the collaborative projects. Secondly, these halo effects do pay off for these participating enterprises, which are able to attract many more higher education institutions to purchase their tailored technology and products generated from the existing educational collaboration. The rationale is that through participating with partner universities on the improvement of certain course quality, enterprises can have a better understanding of where university courses or teaching can be improved and the exact selling points of themselves. Although they have to provide financial support to these partner institutions, they can sell their products to a broader range of low-tier institutions which run the same programs and have the same demands for education quality improvement. Thirdly, against such a bigger context as mentioned above, some enterprises have especially targeted university education shortfalls as the business scope, hence creating more industry chains and rapid financial growth.

As such, there is an activated flow in terms of capital, resource, and benefits running between the three important stakeholders of the innovation ecosystem: the government, the enterprises, and the higher education institutions. Such a flow plays an underpinning role

in sustaining the full-swing university-industry collaboration and the innovation ecosystem at large.

4.2.3. Sustaining Higher Education Quality with Industrial Technological Expertise

Another important aspect of the higher education innovation ecosystem is manifest in the fact that there has been massive industrial technological expertise brought into the higher education system for its quality enhancement and sustainability. As can be seen from the MOE special platform where all enterprises list their technological strengths, which is the third type of data analyzed, every participating enterprise, while applying to be recognized by MOE as an appropriate and qualified collaboration partner, has to explicate what specific technological expertise or state-of-the-art technology it will bring to relevant university partners.

For instance, China's Internet giant Baidu writes to offer its Apollo Technology and smart network vehicle test areas to help partner universities and colleges with their praxis education. Baidu also establishes its own special online platform, Baidu Pinecone School, for collaborating with higher education institutions throughout China in terms of course collaboration, engineering education alliances, college student academic contests, student internships, practical education, and so forth. Co-building laboratories for emerging technology such as AI, cloud computing, and big data within higher education institutions is also on Baidu's agenda, with the contextualization of education contents being a prioritized area. Another example is Intel which contributes to the collaborative education in various manifestations with its own technological might, such as AI-oriented OPENVINO software platform, deep learning and machine learning course contents, big data AI platform, oneAPI and cloud computation resources, Intel FPGA programming, etc. Intel's collaboration with universities and colleges covers multiple categories including teaching content and course structure reform, faculty training, practical competence building, entrepreneurship, and start-up education, the "Four New" project collaboration.

For all intents and purposes, ushering in technological strengths from the industrial sector to update and renew existing university course contents, if not reconfiguring them, is an important telos of the full-scaled university-industry collaboration and the higher education innovation ecosystem over the years. Industrial participation and integration with the industrial sector have been found to be significant factors in sustaining university faculty and students' commitment to effective teaching practices and ensuring that the higher education system keeps up with the technological momentum and does not lose out.

4.2.4. Six Categories of Collaboration at Macro and Micro Levels

The innovation elements of the created higher education ecosystem are mainly manifest in six categories of university-industry collaborative education at both macro and micro levels according to various policy documents and the MOE internal journal. The six categories are (1) "four new projects" (New Engineering Education, Emerging Agricultural Education, New Medical Education, New Humanities Education) co-promoted by both the industry and higher education sector (macro level); (2) teaching contents and curricular system reform (micro level); (3) faculty training projects (micro level); (4) praxis education condition improvement and base development (micro level); (5) entrepreneurship education and reform (micro level); and (6) entrepreneurship education funding project (macro level).

For the first category, the "four new projects", a high degree of cross-disciplinary and collaborative elements are especially emphasized. The traditional disciplinary barriers to changing teaching practices that make student learning fragmented are sonorously called to be tackled. With the industry sector ushered in to tide universities and colleges over, collaboration between academia and industry in charting the overall direction of these important areas has been underscored.

The second category concerns the reform of the teaching contents and the course structure on campus. Universities and enterprises are required to have intensive and extensive discussions and communications on what type of talents are especially needed in the new

times, and jointly set up standards, schemes, and education plans for cultivating high-caliber application-oriented students that cater to industrial demands. Higher education institutions, making use of enterprises' funding, expertise, technology, and platforms, are expected to provide students with many more state-of-the-art resources, such as authentic engineering cases, forefront technology, or highly applicable package instruments.

The third category regards the training of faculty members with more exposure to frontline industrial experiences. The training is arranged to be bidirectional, with enterprise experts entering campus classrooms on the one hand, and faculty members invited to enterprises' R&D or production lines on the other. The purpose is to cultivate double-type-capacity of faculty members, namely the substantive competence both in theoretical knowledge and application.

The fourth category is the co-development of higher-quality infrastructure for praxis education by both the industrial and academic sectors. Universities and colleges are expected to leverage industrial resources (e.g., hardware, software, laboratories, practical education bases) to make up their own natural shortfalls in the delivery of practical education for students. Furthermore, higher education institutions are expected to learn from the companies in terms of talent cultivation efficiency, labor division, artifacts, and subjects.

The fifth and sixth categories are to deepen the reform of innovation and entrepreneurship education carried out in universities and colleges. In recent years, entrepreneurship education has been conceived of as an important strategy to boost student employment and even revitalize the economy. In order for such entrepreneurship education to be more pertinent, visionary, and pragmatic, the industrial sector now provides expertise, funding, and investment to help universities pinpoint the crux of student start-ups and incubate potential student projects. A market mechanism is introduced to match social resources with student entrepreneurship projects that are mature, successful, and potentially rewarding.

4.3. Question 3: What Is the Preliminary Impact of China's Effort thus Far?

4.3.1. Deepened and Extensive Participation in Higher Education Quality Improvement by Multiple Types and Tiers of Stakeholders

Unlike many other initiatives where only a small proportion of universities, mostly premium universities, take an active part, the participation in the development of the higher education innovation ecosystem over the past few years has been in its entirety, including various types of stakeholders across different tiers. For the government bodies, participating institutions include not only the State Council, state-level ministries, and commissions, but also provincial and local government bodies that issue more concrete province or city-wide implementation plans to provide supportive resources and facilitate boundary spanning exchanges and integration. For enterprises from the industrial sector, those participating ones involve not just internationally renowned cross-national companies (e.g., Google, Intel, Microsoft) and leading Chinese IT companies (e.g., Huawei, Tencent, Baidu, Ali), but a large multiplicity of small and medium-sized enterprises and emerging technology-focused training companies as well. These companies cover a wide range of areas that constitute the main pillar of the Chinese economy, such as information technology, software, education, manufacturing, R&D, and the service sector. For higher education institutions, not only do those first-tier institutions striving for the status of world-class university or world-class discipline join the ecosystem establishment and advancement, but also many more second-tier and third-tier institutions have collaboration opportunities with the industry sector in myriad forms. As a matter of fact, 75% of the top-20 higher education institutions that have the most educational collaboration projects with enterprises from 2015 to 2020 are less known ordinary universities and colleges in China according to the MOE internal journal, which is the second type of data analyzed (MOE Internal Journal, No. 3, Table 2).

Apart from the broadness of the stakeholders involved, the justification of the higher education innovation ecosystem is also underpinned by the large territorial scope where such educational collaboration and innovation takes place. The MOE internal journal

reveals that from 2015 to 2020, there are a total of 61,582 educational collaboration projects successfully established across 33 provinces, municipalities, and special administrative regions (Tables 4 and 5). Participating higher education institutions cover 33 provinces, municipalities, and special administrative regions (Table 4), while the number of participating enterprises is 28 (Table 5). That means for several provinces, no enterprise has been involved in such an innovation ecosystem, indicating the relative backwardness of economic development in such places.

Table 4. HEI's Participation in University-industry Educational Collaboration Projects by Region from 2015 to 2020 [30].

No	Province/Municipality/SAR	Participating Higher Education Institution Number	Number of Projects Involving Local HEIs
1	Shandong	82	8603
2	Jiangsu	82	4150
3	Hubei	68	4121
4	Liaoning	62	3683
5	Zhejiang	64	3485
6	Shaanxi	61	3274
7	Guangdong	73	3047
8	Beijing	76	2985
9	Sichuan	57	2968
10	Henan	62	2928
11	Hunan	44	2824
12	Chongqing	26	1762
13	Fujian	45	1718
14	Hebei	63	1659
15	Shanghai	44	1532
16	Jiangxi	42	1526
17	Jilin	42	1513
18	Anhui	43	1461
19	Heilongjiang	42	1440
20	Tianjin	28	1312
21	Gansu	23	1071
22	Yunnan	33	956
23	Guangxi	38	858
24	Shanxi	28	841
25	Inner Mongolia	20	655
26	Guizhou	29	482
27	Xinjiang	19	294
28	Ningxia	8	203
29	Hainan	8	139
30	Qinghai	3	51
31	Tibet	3	36
32	Hong Kong	4	4
33	Macau	1	1
	Total		61,582

Table 5. Enterprises' Participation in University-industry Educational Collaboration Projects by Region from 2015 to 2020 [30].

No	Province/Municipality/SAR	Participating Enterprises	Number of Projects Involving Local Enterprises
1	Beijing	319	24,957
2	Guangdong	119	8019
3	Shanghai	120	5608
4	Shandong	97	4285
5	Jiangsu	86	3729
6	Zhejiang	75	3519
7	Hubei	45	2161
8	Fujian	36	1525
9	Tianjin	20	1177
10	Hunan	17	757
11	Sichuan	19	750
12	Hainan	1	749
13	Henan	16	734
14	Shaanxi	15	702
15	Anhui	12	655
16	Chongqing	14	631
17	Liaoning	22	526
18	Jilin	5	438
19	Jiangxi	4	204
20	Inner Mongolia	1	182
21	Shanxi	3	86
22	Hebei	1	57
23	Guizhou	4	50
24	Heilongjiang	2	33
25	Xinjiang	1	19
26	Guangxi	2	17
27	Ningxia	2	9
28	Yunnan	1	3
	Total		61,582

4.3.2. Change of Instructors' Teaching and Students' Learning at Individual Level

Apart from the changes in the relationship ties of different stakeholders, from previously fairly loosely connected to the current inextricably intertwined, the most salient changes resulting from the establishment and operation of the innovation ecosystem are manifest in instructors' teaching and students' learning. Such changes have in fact been the telos of all the efforts made by the national government and other non-education stakeholders during the process of synergy and collaboration.

Problem-based learning, project-based learning (PBLs), and cross-disciplinary education have become prevalent in many higher education programs with the assistance of industrial forces according to our second type of data. For instance, the University of Electronics Science and Technology of China works closely with an AI-focused high-tech company, Cloudwalk, in Chengdu to redesign their course structure and deepen the teaching reforms (MOE Internal Journal, No. 17, Table 2). Traditionally, students were asked to fulfill designated steps in praxis courses, inculcated with stereotyped experiment schemes. The process more often than not precipitated students to be passive learners, without motivating them to take an active role in integrating the phenomenon they saw

with the theories they had learned. Moreover, the emphasis on outcomes rather than the experiment process failed to assess students' real learning. Now with Cloudwalk stepping in, both parts have extracted key technologies into typical cases from authentic industrial projects. Imitating the authentic design procedures in the industry, students are allowed to design their own schemes, collect data on their own, test their hypotheses, search for the experiment results, and report outcomes based on the division of labor. Furthermore, with the help of the frontline package instruments frequently used in the company, such as OpenCV and Python, students are working on projects that have substantive meanings to the social context, such as campus-wide cross-camera capturing of human body movement, rather than working on merely simulated prototypes. A similar implementation of PBLs abounds in other media outlets when it comes to the impact of the synergy between the industry and the higher education sector, given the current ecosystem.

The increasing delivery of cross-disciplinary education is another jewel of the ecosystem established, which is aimed at addressing the long-standing disciplinary barriers documented to prevent students from being exposed to different areas and having a comprehensive understanding of their knowledge utility. Xi'an Jiaotong University offers a typical example of aggregating cross-disciplinary forces for student learning improvement (MOE Internal Journal, No. 4, Table 2). It launches a special type of class named Jingying Class, for which the university mobilizes extensive resources internally from different schools and externally from the business sector and R&D departments. In the spirit of cross-disciplinary education, Xi'an Jiaotong University sets up a total of eight cross-disciplinary innovation praxis platforms, named "mechatronics", "smart mini-grid", "new energy", "smart aircraft", "information control", "new material", "smart architecture", and "biomedicine" respectively. Each of the eight platforms is beyond what one or two individual disciplines can underpin, but is afforded by talents, resources, and manpower from at least four different disciplines. Each platform also provides a number of different modules to train students' project design competence, inter-disciplinary mindsets, and the application of knowledge across different fields.

4.3.3. Increased Shared Governance Practices at Institutional Level for Education-Focused Collaboration

Out of the need to develop synergy for educational collaboration with different stakeholders, many higher education institutions have embarked on reforms to their governance structure and included industrial representatives to take up formal institutional positions. It is a consensus at the institutional level that a higher degree of shared governance bears the advantage of giving rise to lasting change premised upon widespread engagement and multiple resource support.

An example is Dongguan University of Technology which has instituted a special Management Office for Modern Industrial Institute to be responsible for the collaboration affairs with the industrial sector and the government. The board of trustees of this office consists of both faculty members, institutional administrative members, and representatives from relevant enterprises and industrial associations. Such a diverse body of committee members work together on plenty of substantive engineering education at the university, such as co-developing the overall student attribute outlines, quality assurance mechanisms, course development, and so forth. Both university representatives and industry representatives have a say in charting the direction of the faculty community and developing different levels of student projects that encompass authentic engineering settings, workplace demands, and real R&D cases. Furthermore, according to its institutional governance structure, representatives from a collaborative enterprise take up the position of vice director for the Modern Industrial Institute (MOE Internal Journal, No. 14, Table 2).

4.3.4. Reflections on the Sustainability System

The content analysis of the various types of data also reveals that the public responses in China towards the current stages of the development higher education innovation

ecosystem is not merely self-congratulatory or enthusiastic, but also self-reflective and attuned to the existing and potential problems.

For instance, the MOE internal journal, the second type of data we collected, unfolds several "unevenness" regarding the current participation of different stakeholders in the collective ecosystem building. The first "unevenness" is reported to be the uneven intensity of the focus on the six categories of collaboration. Among the aforementioned six categories of university-industry collaboration, the first, fifth, and sixth categories have been less attractive for enterprises to be engaged with than the other three categories. This shortfall is believed to derive from the insufficient catering to important national strategies on the part of enterprises. The second "unevenness" concerns the geographic unevenness of participating higher education institutions and enterprises. Most participating higher education institutions are reported to concentrate in several provinces such as Shandong, Jiangsu, Zhejiang, and Guangdong. A similar situation applies to enterprises as well, with most supporting enterprises located in eastern developed regions. Those located in less developed Southwest and Northwest regions of China have participated little in the national ecosystem development project. This is deemed as a result of insufficient resource support and dissemination of the effective implementation of the university-industry collaboration and the higher education ecosystem at large. The third "unevenness" is about the domains of specialty of participating enterprises from the industrial sector. Currently, most participating enterprises are reported to have a high concentration in information technology, but companies from other major economy-underpinning areas such as chemical engineering, medical engineering, or mining are believed to be able to play greater roles in the future. This shortfall is attributed to insufficient research on the distinctive features and characteristics of different industries as well as their compatibility with participating higher education institutions.

5. Discussion

The present study has analyzed Chinese efforts to establish a sustainable higher education sector over the past few years by covering the rationale, the constituents, and the preliminary impact of the sustainable higher education sector. The data analysis in the study corroborates the essential elements of a sustainable entrepreneurial university identified in the literature. The following sections will discuss the findings in relation to how China's effort to strengthen its sustainability-oriented higher education embodies the elements of a sustainable entrepreneurial university. At the same time, the Chinese practices, while partially fitting the notion of the sustainable entrepreneurial university, have their unique characteristics, based upon which we will unravel how China attempts to build a higher education innovation ecosystem to underpin such a sustainability goal.

5.1. The Application of the Sustainable Entrepreneurial University in the Chinese Context

Recent years have witnessed the emergence and application of the sustainable entrepreneurial university to denote the comprehensive transformations of university reforms, mostly in the European context [20]. The European effort, through highlighting the responsive roles of universities in catering to the multi-dimensional societal needs (e.g., ethical need, environmental need, industrial need, economic need) based upon the involvement of multiple stakeholders, has been transforming the higher education sector and the broader society towards an innovation ecosystem. In fact, such an idea of university transformations is also visible in the Chinese context where a broad range of stakeholders have been coordinated through policy efforts to prompt changes at macro and micro levels in higher education.

In the first place, it is a conspicuous awareness for China that the gap between the higher education sector and the broader societal needs means unsustainability for the overall societal progress in the new times. On the contrary, shrinking the gap and bridging different stakeholders for the collective education purpose are viewed as means to achieve sustainability. The emphasis placed on quality in relation to an array of aspects, such as student attributes, employability, teaching and learning culture, and assessment has

demonstrated that pursuing sustainability in a comprehensive manner is now regarded as a fundamental means to serve the purpose of the overall societal aspirations by adopting a multiple stakeholders' interaction and mutual support-featured approach.

Identifying with the feature of SEU from technology transfer to knowledge exchange and co-creation [26,31], the Chinese effort in recent years has placed a strong emphasis on knowledge creation by stakeholders across sectors, not just limiting to academia as the traditional knowledge creation body. The content analysis of China's national policies in this study reveals that bringing in industrial and social stakeholders has been cast as an important strategy to update the knowledge and facilitate instructional development on campus. As revealed in the data, co-developing student talent outline, education infrastructure, and course contents have been taken up by both universities and collaborative enterprises, with government bodies issuing supportive policies and mechanisms to fuel such ties across sectors.

The current university-industry interaction patterns as revealed in the data speak to the idea of bi-directional knowledge flow described by Geuna and Muscio [32]. Within such a framework, knowledge is not merely transferred from one part to another but flows between different sides for value co-creation. For instance, in the Chinese practices, enterprises have infused the higher education sector with state-of-the-art technological expertise on the one hand, and also revised and updated their product based upon the feedback from the university side in terms of the compatibility between what enterprises can offer and the course structure at universities. Moreover, there has also been capital flows from the government and society to both enterprises and universities to fuel such knowledge and value co-creation.

5.2. Sustaining the Higher Education Sector through Building a Higher Education Innovation Ecosystem

Apart from embodying elements of the conceptualized sustainable entrepreneurial university, the Chinese efforts have signaled the national attempts to build a higher education innovation ecosystem at large to sustain the higher education sector. Among various conceptions of the concept, one of the most widely used definitions of the innovation ecosystem is "the collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution" [33], which is derived from the related concept of the business ecosystems, in which an innovation ecosystem is used to refer to a loosely interconnected network of entities across sectors that coevolve capabilities around a shared set of technologies, knowledge, or skills, and work for the development of new products and services. A decade later, the innovation ecosystem evolved to stand for the "inter-organizational, political, economic, environmental, and technological systems of innovation through which a milieu conducive to business growth is catalyzed, sustained and supported" [34], characterized by a continual realignment of synergistic relationships in response to the changing internal and external forces [9]. Dependences among organizations' different members, a shared set of objectives and goals, and a common and complementary set of knowledge, skills, technologies, and capabilities are identified as key defining characteristics of an innovation ecosystem [35–37].

In this study, we unravel a "higher education innovation ecosystem" from the Chinese policies to express a situated uptake of the innovation ecosystem in the context of Chinese higher education. The concept signals a Chinese approach to creating synergistic relationships through forging interconnected networks of entities across sectors for the shared set of goals and objectives in educational development at the post-secondary level. In this ecosystem, dependences among different stakeholders based on their complementary skills and capabilities are substantive, pragmatic, and illuminated. It is about the way in which resources, capital, and expertise are mobilized to form mutual support among the government, enterprises, higher education institutions, and social forces for a collective educational goal and a win-win educational outcome.

Viewing the university-industry collaboration in the global context, collaboration for educational purposes has been sparse compared with collaboration in research or

other aspects that tend to yield visible and rapid results [14], except for a few existing studies that have evidenced such practices across the globe in the past decade [38–40]. This study presents the latest landscape of the Chinese higher education sector, where different stakeholders such as the government, businesses, universities and colleges, and social forces have strengthened collaborative ties for the sake of educational purposes. There is a higher education innovation ecosystem gradually established as the government, industry and higher education sectors focus their attention on Chinese university students' learning.

Compared with China's own history of higher education, the extent to which synergy occurs among different stakeholders for enhancing higher education quality has been unprecedented. Such a landscape echoes existing literature that the successful innovation ecosystem depends upon the overall innovation performance resulting from the collaboration among focal stakeholders, component partners, and complimentary partners [9]. In the Chinese context, the higher education institutions across tiers are the focal stakeholders researched, whereas the government, enterprises, and social forces serve as component partners, supporters, fund-raisers, and also beneficiaries during the whole collaboration process. The interaction patterns among these stakeholders are not simply the sum of individual members' performances. The collaborative arrangements oriented towards a shared higher education telos have been salient, with political, economic, inter-organizational, and technological elements collectively involved to sustain a higher education innovation ecosystem [35,36].

The most important essence of the Chinese innovation ecosystem of higher education is the intensive infusion of elements and resources outside higher education into the traditional university course system to change the milieu of the traditional teaching featured with lecture-based pedagogy and textbook-based education instruments [38,41]. Such elements and resources include intellectual expertise, financial investment, technical guidance, and other types of professional contributions, which underpin the feasibility and part of the sustainability of the current overall innovation milieu. Over the past few years, along with the rapid increase in the quantity of relevant collaborative projects, the initiative has had the most impact on students' learning experiences at individual and course levels, to a large extent promoting college and university students' praxis education, exposure to authentic workplace settings and projects, use of the state-of-the-art package software and applications, knowledge of what the industrial sector truly demands, and increased motivation for learning obsolete and abstract technical and theoretical knowledge in the field of engineering, agriculture, medicine, and humanities. As shared assets, standards, and interfaces, as well as complementary innovators, are critical underpinnings of an activity system that strives for innovation for collective aims and goals [42,43], the different stakeholders in the Chinese context have provided new value to each other basically on the unified platform, built by MOE, where each stakeholder can get complete access to relevant policy contents and potential partners' information prior to and during the different phases of collaboration.

At the same time, the Chinese reflections on their own shortfalls in creating and sustaining the higher education innovation ecosystem identify some factors that are perceived to lead to cooperative innovation performance in empirical studies, such as structural dynamic, location of members, and members' heterogeneity [9]. The uneven geographic distribution of participating enterprises, universities, and colleges is what China aims to further resolve in their future endeavors on the innovation ecosystem, and so is the intention to include players from a broader range of industries for more heterogeneity. As collaboration, communication, choice, consideration, continuity, and community combined provide solutions to complexity in a professional synergistic relationship [44], how to sustain the collaborative ties among different stakeholders with the above necessary elements comes to occupy a prominent place in making future endeavors of the higher education innovation ecosystem.

6. Conclusions

This paper conducts an analysis of the policies, implementations, and effects of the recently developed Chinese higher education innovation ecosystem. With respect to why China is striving to establish a sustainable higher education sector, quality improvement dominates the rationale for building up the sustainable higher education sector, with quality being a high-frequency keyword across a total of 16 sampler official policy documents. To achieve such a quality goal, China has realized the need for building a higher education innovation ecosystem in which multiple stakeholders co-work in a synergistic approach to fueling the higher education quality at various levels. Regarding the path to achieving a sustainable higher education sector, various national policies have stipulated roles of different stakeholders based on collaboration and division of labor, with a major purpose to reduce the gap between the provision of education on campus and the demands on the part of the industry. Such collaboration and division of labor are based upon capital flow and resource mobility rather than mere slogans or policy intents, which motivates the industry to inject technological expertise into the university system to prop up higher education sustainability. MOE has distinguished a total of six categories of collaboration at macro and micro levels to promote synergy between industry and universities. As for the preliminary impact of China's effort so far, deepened and extensive participation in higher education quality improvement by multiple types of stakeholders has unfolded. Thousands of higher education institutions and businesses have forged such relationships of collaboration, and such stakeholders also spread across different tiers, including both premier business and higher education players and less-known ones. Furthermore, instructors' teaching and students' learning at the individual level have witnessed pattern changes, and social forces have been more engaged in institutional governance issues compared with Chinese higher education's own past. At the same time, it is worth noting that the public responses in China towards the current stages of the higher education innovation ecosystem are also filled with reflections, particularly on the unevenness across the six stipulated categories of collaboration and the geographic unevenness.

Overwhelmingly, there has been pronounced progress made regarding the synergy and collaboration between the government, the industry sector, the higher education sector, and the social forces compared with China's own past. It is especially worth mentioning that such synergy and collaboration are education, teaching, and learning-focused, with its impact unsurprisingly manifest not only at macro policy levels but also at micro course levels. Against such a backdrop, student learning can be touched, and the quality issue, which constitutes a central concern of almost every piece of higher education literature, is partly catered to. There have also been governance reforms in some higher education institutions to better cater to the demand of collaborating with other stakeholders.

The findings in the present study contribute to the theme of sustainable higher education in several ways. Firstly, through scrutinizing China's development of the sustainable higher education sector, we have applied the emerging conceptualization of sustainable entrepreneurial university, which derives from the European context, in China where the political and institutional environment is different. As an ideal type of university to embody the new societal engagement roles expected of higher education institutions, the concept of a sustainable entrepreneurial university has been validated to apply not only in the European context [20] but also in the Chinese context where different types of stakeholders are coordinated to play their socially responsive roles in co-creating sustainability in higher education. Secondly, we have put forward another concept of a higher education innovation ecosystem to enlarge the extant body of literature on innovation ecosystems that have mostly been applied in the business sector. As the analysis of the cluster policies conveys, a higher education innovation ecosystem featured with interconnected networks of entities across sectors gradually unfolds. Thirdly, the study has provided its empirical value in unraveling how the higher education innovation ecosystem has been strengthened through extensive government coordination and substantive resource affordance. The capital flow, for example,

as the invisible hand in making possible the cooperation between different stakeholders provides empirical insights into the essence of substantive cross-departmental collaboration.

One limitation of the paper should be noted for its adoption of content analysis as the only way of the research method. Detailed policy intents and preliminary impact have been rendered visible, and yet the challenges in the process of implementation have not been addressed. Nationally, the sheer size of China's effort to develop the sustainable higher education sector and the higher education innovation ecosystem is part of its overall national project for the development of world-class universities and world-class disciplines as shown in a wealth of literature. Internationally, China's attempts have resulted from the global technological advancement in the times of Industry 4.0 and its new demands for higher education quality. As such, the country realizes that to achieve a real sustainable higher education sector, the measures it needs to take should be a system and ecosystem-oriented overhaul of the higher education system, rather than tinkering with the current system with mere superficial changes. However, given the temporal proximity since the issuing of relevant policies analyzed in this study, which mostly yields the visible progress in size and quantity terms, the challenges in the implementation of these full-scaled teaching and education-focused collaborations between various stakeholders are yet to be investigated as well in future studies. Thus, based upon the findings of the present study that indicates the increase in different stakeholders' engagement and participation in higher education affairs, future research points to the employment of more empirical methods such as interviews and ethnographic observation to unravel the possible challenges that may exist in the interaction between the broad range of stakeholders in co-developing the higher education innovation ecosystem.

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