Article

Aligning Engineering Education for Sustainable Development through Governance: The Case of the International Center for Engineering Education in China

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Abstract: Engineering education plays a key role in the progress toward achieving the 17 Sustainable Development Goals (SDGs). However, engineering education faces many challenges worldwide, and the issues are becoming increasingly complicated because of the COVID-19 pandemic. To deal with these challenges and achieve the SDGs by 2030, governance that aligns engineering education and SDGs is badly needed. The International Center for Engineering Education (ICEE) has taken a series of governance actions to align engineering education and sustainable development. This research presents the contribution of these governance actions, analyzes the governance types and their relevance to the SDGs, and explores the key mechanisms of these governance actions and challenges. This research can provide useful information for the global community to understand China's participation in global engineering-educational governance and promote engineering education for sustainable development.

1. Introduction

In 2015, the United Nations approved the 17 Sustainable Development Goals (SDGs) and the 2030 Agenda for Sustainable Development to achieve these goals. The 17 goals comprise a broad range of social, environmental and technological issues from poverty reduction, good health, industrial innovation, quality education, and gender equality, to the sustainable use of energy and clean water [1]. All 17 goals can be related to engineering and requires solutions rooted in engineering [2]. Engineering has a wide range of effects on human society and nature. It contributed to our ability to survive disasters and public-health challenges, to secure food and water, to communicate and travel, and to innovate and create new products and services [3]. Thus, engineering plays a central role in the creation of a more sustainable world. Given the crucial role that engineering has in shaping the development of our society, engineering education is critical for sustainability [2–5].

However, engineering education faces many challenges worldwide. First, the number of graduates in engineering fields has declined compared to other fields in the last 20 years, according to data from the UNESCO Institute for Statistics (UIS) [6]. "Escaping engineering" is becoming a common phenomenon. Decreasing numbers of students choose engineering as their major, and engineering graduates prefer to work in other fields such as business [2,7,8]. Second, gender inequality in the field of engineering is still present, and girls are not encouraged to become engineers in many places [9–13]. Third, the regional development of engineering education is unbalanced, and regional engineering capabilities vary greatly. The first UNESCO Engineering Report 2010 shows that there are 20–50 scientists and engineers per 10,000 people in developed industrialized countries, but developing countries have an average of just 5 scientists

and engineers, while in poorer African countries this number drops to 1 or less [3]. Ten years later, this issue has not changed significantly. In Swaziland, for example, there is less than 1 engineering graduate for every 170,000 people; by comparison, in the United Kingdom, there is 1 engineering graduate for 1,100 people [2]. Fourth, new technologies brought by the Fourth Industrial Revolution (Industry 4.0), which include artificial intelligence, robotics, 5G networks, cloud computing, 3D-printing, blockchain, and digital healthcare, are becoming more complex and will change job types, career paths, and the ways in which people work [14]. This requires changes and innovation in the content of engineering education and a shift toward problem-based, project-, context-, and challenge-based learning [15–17]. Fifth, the spread of COVID-19 makes these challenges more difficult to solve, and poses new, additional challenges. For example, the large-scale use of remote learning has become very common since the outbreak of COVID-19. This enlarges the gap in the development of engineering education in different regions, since developing countries have poor digital infrastructures and ICT technology compared to developed countries. Moreover, the spread of COVID-19 also has a negative influence on the mobility of international engineering students and international exchanges and cooperation on engineering education. In order to deal with these global challenges, governance that integrates engineering education into sustainable development across the world is badly needed.

The concept of global governance was proposed initially to address global issues. To understand this concept, we need to clarify the meaning of governance first. Governance is the sum of the many ways in which individuals and institutions, public and private, manage their common affairs [18]. It is a part of human activity concerned with "creating the conditions for ordered rule and collective action" [19]. When this activity transcends the bounds of the nation-state and involves multiple actors in policy production and implementation on global, national, and local scales, the concept of global governance emerges [20]. As Rosenau states, "global governance is conceived to include systems of rule at all levels of human activity in which the pursuit of goals has transnational repercussions" [21]. The Commission on Global Governance defines global governance as "the formation of a series of formal and informal institutional arrangements through participation, negotiation and co-ordination by various actors, such as governments, various international organizations, and private or public institutions, to deal with the common challenges that mankind faced, such as ecological and environmental issues, to enhance the well-being of all human beings" [18]. Global governance relates to the interaction and collaboration between myriad entities emanating from various societal and professional orientations, which form networks to address issues that threaten local and global communities [22]. Global governance should be considered as covering the overlapping categories of functions performed internationally, including: information creation and exchange, the formulation and promulgation of principles, the promotion of consensual knowledge affecting general or particular issues concerning humankind, efforts to influence the behavior of states, and assistance in the advancement of human development [23]. Broader opinion can influence policy choices, and the interconnectedness of the world makes the idea of global governance important, exciting, and worthy [24].

The topic of global governance is important to scholars of world politics and economics. However, few efforts have been undertaken by education scholars to explore global educational governance in the last decade [20]. Global educational governance refers to actors, such as governments, international organizations, multinational companies, think tanks, and mass media, using participation, dialogue, negotiation, and cooperation to build consensus and construct a series of mechanisms or rules that can influence the development of international education. In recent years, a growing body of literature has focused on international organizations and their global governance activities in the educational area. International organizations have placed increasing emphasis on education, and they have become powerful actors in education [25]. UNESCO, OECD, and the World Bank are three important international organizations in the global education discourse and they have been repeatedly found to be the most relevant organizations in educational

policymaking worldwide [26]. Researchers have identified the typology of international organizations' global governance activities in education based on the instruments that international organizations use. For example, UNESCO 's governing instruments include conventions (such as the Global Convention on the Recognition of Qualifications concerning Higher Education), educational concepts (such as Education for All and Lifelong Learning), conferences (Global Education Meeting), and research-based knowledge (Global Education Monitoring Report). UNESCO has been successful in garnering continuous support for its Education for All initiative since 1990 and has recently taken the lead in global educational reporting through its Global Education Monitoring Report (GEMR), its flagship publication [27]. The major global educational governing instruments developed by the OECD are "governing by numbers, governing by comparison, governing by example, governing by commensuration, governing by affection", etc. [28]. The World Bank is the largest funding and project-implementing institution in education in the world. Financial aid and scientific knowledge-sharing are the two major instruments that the World Bank using for global educational governance [29]. These governing instruments are categorized into two types: hard (coercive, or formal) and soft (normative, or informal) influence mechanisms. For instance, convention or regulation and funding are forms of hard power; and educational concepts or research knowledge are forms of soft power. Although it is difficult to empirically examine the differential impact of these types of governance, it seems that IOs are well placed to influence nation-states by forcing, paying, talking, persuading, pleading, and socializing [30]. Previous research has fully explored the types of international organizations' global governance activities in the field of education. However, there is a gap in the specific field of engineering education on which the global governance activities to align engineering education for sustainable development has not been as focused, especially in China.

China takes the implementation of the 2030 Agenda for Sustainable Development as a high priority and commits to promoting sustainable development in all areas [31]. Thus, China supported UNESCO to set up the International Center for Engineering Education (ICEE) in China in 2016, which is the only UNESCO Category II center named after engineering education. This international center aims to promote the concept of sustainable development in engineering education. It has taken a series of governance actions to align engineering education and sustainable development. The objective of this research is to present the contribution of these governance actions, analyze the governance types and their relevance to the SDGs, and explore the key mechanisms of these governance actions and the challenge of achieving the SDGs through global governance. This research can provide useful information for other countries or regions to promote engineering education for sustainable development.

Research questions:

1. What global governance effects does ICEE have on engineering education?
2. How do these governance activities relate to the SDGs?
3. What is the key mechanism of these governance actions and how do they help to meet the challenge of achieving the SDGs?

2. Methods

This study employs a qualitative methodology based on a case-study approach. A case study is an empirical method that investigates a contemporary phenomenon (the 'case') in depth and within its real-world context; such an understanding is likely to involve important contextual conditions pertinent to the case [32]. Therefore, it is advantageous to investigate the in-depth and detailed information on the effects of global governance actions on engineering education in the context of ICEE's practice.

2.1. The Case

This research focuses on the case of the International Center for Engineering Education under the auspices of UNESCO (ICEE). ICEE can be dated back to the educational research

office of Tsinghua University, which was founded in 1979. This office then became the Center for Engineering Education, Tsinghua University, which was founded in 2008. Later, the Center for Engineering Education, Tsinghua University, became the China Academy of Engineering—Tsinghua University Center for Engineering Education, in 2014. The vision of ICEE is to build an equal, inclusive, developmental, and universally beneficial global engineering education community for the promotion of quality and equity in engineering education amongst all countries in the world. The mission of ICEE is to be a think tank for policy research, an incubator for high-caliber personnel, and an exchange-and-cooperation platform in global engineering education. As shown in Figure 1, ICEE pursues quality engineering education worldwide by building global networks, strengthening industry–university collaboration, and developing innovation-driven university education. The center focuses on talent cultivation in engineering for developing countries on the path of innovation-driven education and industry–university collaboration to support these countries in pursuing sustainable social and economic development, which will benefit individuals, local communities, countries, and the whole of humankind [33]. The organizational structure of ICEE includes the governing board, the advisory board, the executive committee, and four departments. As shown in Figure 2, the governing board is the decision-making body, the advisory board is the consultation body, and the executive committee is responsible for the regular operational and administrative affairs.
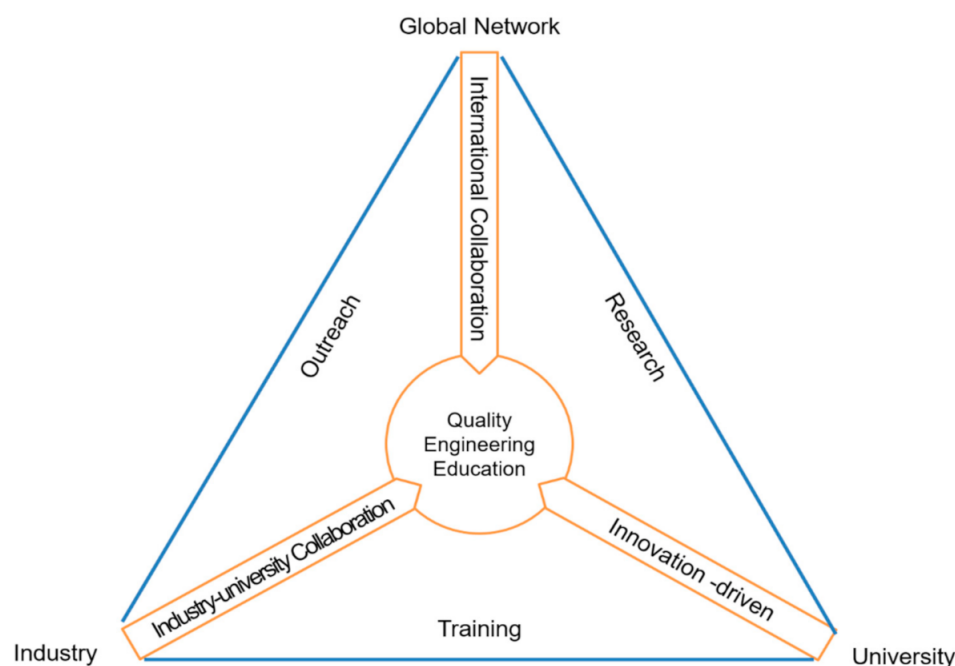
Figure 1. The mission of ICEE.

This paper reports on single-institution research, but this research and its contributions are notable for many reasons. As a Category II center of UNESCO, ICEE takes SDGs as its action framework, and it is committed to aligning engineering education with sustainable development. ICEE was proposed jointly by Tsinghua University and Chinese Academy of Engineering (CAE). Tsinghua University is one of the world's most prestigious universities and it is well known in the field of engineering education. China Academy of Engineering is a national consulting organization in engineering science and technology in China. It represents the capacity of engineering and engineering education of China. The various members of ICEE's governing board and advisory board are from Tsinghua university, China Academy of Engineering, China Engineering Education Accreditation Association, Massachusetts Institute of Technology, World Federation of Engineering Organizations, International Federation of Engineering Education Societies, Global Council of Engineering

Deans, Africa Engineering Education Association, European Society for Engineering Education, Engineering Academy of Japan, and other international institutions. ICEE shows the international cooperation of these organizations, which is a good example of effect of multi-agent synergetic governance on engineering education globally. ICEE is an important platform and window for China to participate in global engineering education governance through UNESCO. This research can help to understand China's participation in the global governance on engineering education.
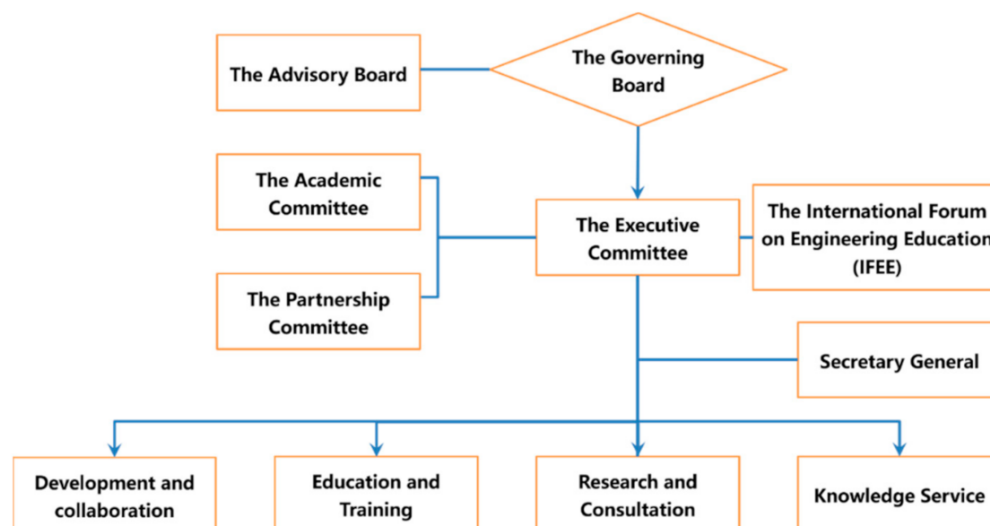
Figure 2. The organizational structure of ICEE.

2.2. Data Collection

Data were collected from documentation and text analysis. Documents play an explicit role in case-study data collection, and systematic searches for relevant documents are important [32]. In this research, the documentation includes public information from ICEE' websites or publications and inside information provided by ICEE. Large volumes of materials from ICEE were involved in this research, including annual reports, research reports, speeches, newsletters, meeting minutes etc. The time span of these research data ranges from 2019 to 2021. The documentation studied is presented in Table 1.

Table 1. Information about the documentation involved in this research.

Public Information	Inside Information
Newsletters	Annual reports
News	Work plan
Brochure	Research reports
Briefings of events and activities	Online learning project reports
Articles	Chronicle of events
Videos	International conference/Forum minutes
Speeches	Departmental meeting minutes

2.3. Data Analysis

Techniques for qualitative data analysis involve two cycles of coding. First-Cycle Coding includes elemental, procedural, and language analysis. Second-Cycle Coding is much more challenging; it includes pattern coding, focused coding, axial coding, and theoretical coding [34]. The data analysis focuses on effects of ICEE's global governance actions on engineering education and their connections with SDGs, and the key mechanism of these governance actions and the challenge to achieve SDGs through global governance.

All the ICEE documentation materials were organized, cleaned, and coded through the two cycles of coding using NVivo qualitative research software. In total, 338 documents (texts) and 2 h 7 min of videos were coded in this research. Through data analysis, we identified the typology of global governance activities of ICEE, sketched out their connections with SDGs, found the key mechanism of these governance actions and determined the challenges involved in achieving SDGs through global governance. The results of this analysis are discussed in detail in the following sections.

3. Results

The results from the case study and data analysis are presented in this section to answer the research questions. The typology of global governance in the field of engineering education is presented in Section 3.1. The connections of these governance actions with the SDGs are outlined in Section 3.2. In Section 3.3, the key mechanism of these governance actions is discussed and the challenges involved in achieving the SDGs through global governance are determined.

3.1. The Typology of Global Governance in Engineering Education

We found 3 categories and 14 codes based on the data analysis. The frequency of the codes and the details of the coding are shown in Table 2.

Table 2. Information about the coding process and results.

Categories	Codes (Frequency)	Raw Data (Source)
Governance actions (types)	Governance by ideas (28)	The idea of a global engineering education community rooted in the concept of a community with a shared future for mankind (research report: On the construction of the global engineering education community; minutes: The 2021 ICEE Governing Board and Advisory Board Meeting).
	Governance by standards (23)	ICEE completes the revision of the IEA standard for GAPC. (Annual report 2021).
	Governance by accreditation (31)	ICEE researchers contributed heavily to this process by, for example, establishing the internationally equivalent Chinese engineering education accreditation system, and research work on the rules and procedures of application, which provides guidance and suggestions for China joining in the Washington accord (news: ICEE has made important contributions to China Engineering Education's accession to the "Washington Accord").
	Governance by research (47)	With support from CAE, ICEE has carried out research on major strategic themes, such as "Engineering for Sustainable Development", "Research on the Demand for Engineering Science and Technology Talents and the Reform Strategy of Education Mode for Sustainable Development in the New Era", etc. (annual reports for 2019, 2020, 2021)
	Governance by conference (36)	The second international forum on engineering education was held in 2020 with the theme of "Environment and Sustainable Development" (news: The 2nd International Forum of Engineering Education IFEE 2020).

Table 2. *Cont.*

Categories	Codes (Frequency)	Raw Data (Source)
	Governance by knowledge services (35)	The engineering education knowledge service platform is a comprehensive, international, and non-profit online platform, which integrates data services, information services, and educational services to help people to obtain various educational resources in a one-stop framework (article: The implementation and development of the international program of computer micro-diploma—taking the practice during COVID-19 as an example).
Relevance to SDGs	SDGs (89)	Engineering for sustainable development (research reports, ICEE brochure, news, events)
	Sustainable development (77)	Engineering for sustainable development (research reports)
	Quality engineering education (43)	ICEE pursues quality engineering education worldwide (ICEE brochure, videos of ICEE promotional event)
	Engineering capacity (38)	ICEE aims to bridge the gap in regional engineering capacity (online-learning project reports, international conference/forum minutes).
	Partnerships (68)	In order to achieve the UN SDGs, ICEE consolidated partnerships and participated in global cooperation (annual reports for 2019, 2020, and 2021; news)
Key mechanism	Collaboration/ cooperation (85)	ICEE has continuously strengthened communications and cooperation with international organizations, academic institutions and business partners (Annual report 2019, 2020, 2021; departmental meeting minutes).
	Partner (72)	ICEE's close global partners, including UNESCO, IEA, WFEO, XuetangX, China Academy of Engineering, China Academy of Space Technology, China Harbour, etc. (ICEE website, annual report for 2021, news, newsletters).
	Global network (39)	ICEE constantly expands its visibility and influence by building global networks (work plans for 2019, 2020, and 2021).

3.1.1. Governance by Ideas

ICEE proposed the initiative of building an equal, inclusive, developmental, and universally beneficial global engineering education community. This idea is rooted in the concept of a community with a shared future for mankind. It is a community of belief, rules, actions, and interests, based on a consensus over the relationship between engineering education and the future development of mankind. With the principles of extensive consultation, joint contribution, and shared benefits, the global engineering education community will establish an efficient and equal cooperation mechanism, a flexible and diverse mobility mechanism, a universally beneficial governance mechanism, and an open resource-sharing mechanism. The cooperation mechanism generally involves establishing engineering education cooperation alliance, signing agreements, providing cooperation funds, creating cooperation platforms, exchanging scholars, and organizing conferences jointly. The mobility mechanism aims to improve the internationalization level of engineering education by establishing common standards and accreditation. The governance mechanism refers to the multi-agent synergetic governance model, which aims to achieve universally beneficial development. The open resource-sharing mechanism refers to establishing a global engineering-education database using information and communications

technology, gathering large volumes of high-quality engineering-education resources. This resource-sharing mechanism is charitable and open for all.

3.1.2. Governance by Standards

ICEE has participated in the revision work of the International Engineering Alliance (IEA) Graduate Attributes and Professional Competencies (GAPC) as a core member since 2019. The GAPC profiles defined the expected outcomes for engineering-education programs and competencies for independent engineering practice for three professional tracks: engineer, engineering technologist, and engineering technician [35]. The GAPC framework is the basis of the three education accords and the four agreements. The three education accords are the Washington Accord, the Sydney Accord and the Dublin Accord. The four agreements are the International Professional Engineers' Agreement (IPEA), the APEC Engineer Agreement (APEC), the International Engineering Technologists' Agreement (IETA), and the Agreement for International Engineering Technicians (AIET). Through these accords and agreements, IEA established and enforces internationally benchmarked standards for engineering education and the expected competencies for engineering practice. The GAPC is recognized as a valuable international benchmark for engineering education by more than 30 countries. This revision work will have an important impact on the development of global engineering education in the next 10 years.

3.1.3. Governance by Accreditation

ICEE played an important role in the process of China joining in the Washington accord and the accreditation of engineering education in China. In 2005, China began to explore how to join in the Washington accord. Through the process of research, piloting, and full implementation, China became a full member of the Washington accord in 2016. ICEE researchers contributed significantly to this process by, for example, establishing the internationally equivalent Chinese engineering-education accreditation system, and conducting research on the rules and procedures of application, which provided guidance and suggestions for China joining in the Washington accord [36]. In 2006, only eight majors passed the accreditation. After China joined the Washington accord, the number of majors that passed the accreditation increased significantly. In 2020, 1600 majors passed the accreditation; they were distributed among 257 colleges and universities [37].

3.1.4. Governance by Research

ICEE aims to promote the development of engineering education and sustainable development through research. The most influential research project in which ICEE has participated is the "Engineering for sustainable development" report, the second UNESCO engineering report, which was officially released on World Engineering Day (4 March 2021). As one of the flagship reports of UNESCO, the engineering report is published in English, French, and Chinese, and its executive summary is published in English, French, Chinese, Russian, Spanish, and Arabic. The engineering report highlights the crucial role of engineering in achieving each of the SDGs and provides recommendations for governments, engineering organizations, academia and educational institutions, and industry to forge global partnerships and catalyze collaboration in engineering to deliver on the SDGs. The director-general of UNESCO, Audrey Azoulay, wrote in the preface of the report that "the report is an important milestone in the standard-setting work of UNESCO" [2]. ICEE also provides policy consultation on engineering education by research for the Chinese Academy of Engineering, the China Association for Science and Technology, the Ministry of Education, and other organizations or government departments.

3.1.5. Governance by Conferences

ICEE holds many international conferences about engineering education and sustainable development to share experiences and provide exchange opportunities for stakeholders in the field of engineering education. The international forum on engineering education

(IFEE), which is a major conference held by ICEE, aims to improve the quality of engineering education and achieve the SDGs by engaging engineers. To ensure the quality of engineering education, ICEE organized multiple online education seminars, dialogues, symposia, workshops and conferences after the outbreak of COVID-19 to share Tsinghua's experience of online education during the pandemic by working with Xuetangx, Global MOOC Alliance, and the Online Education Center of Tsinghua University. To align sustainable development in engineering education, ICEE also held the 2021 Engineering for Sustainable Development Symposium, which included discussions on the "Engineering for sustainable development" report.

3.1.6. Governance by Knowledge Services

ICEE provides engineering-education knowledge services for the public by working closely with Xuetangx and the International knowledge Centre for Engineering Sciences and Technology under the auspices of UNESCO. The engineering-education knowledge service platform is a comprehensive, international, and non-profit online platform, which integrates data services, information services, and educational services to help people to obtain various educational resources in a one-stop framework. The platform comprises massive information about engineering education, which includes research literature, policy documents, conferences, academic trends, accreditations, publications, engineering capacity, and online courses.

3.2. *The Relevance of Governance Actions to the SDGs*

The case analysis indicates that sustainable development is the core value of global engineering-educational governance. There is a strong degree of alignment between ICEE's governance activities and the SDGs. The correlations between the governance actions of ICEE and the SDGs are shown in Table 3.

Table 3. The relevance of the governance actions to the SDGs.

Governance Actions	Global Issues Addressed	Objective of the Actions	SDGs
Governance by the idea of a global engineering-education community	International cooperation on engineering education.	Build a wide and close global network	SDG 17. Partnerships for the goals
Governance by standards	Engineering education reform and innovation	Clarify what is the quality engineering education	SDG 4. Quality education
Governance by accreditation	The mobility of engineers	Quality engineering education-resource-sharing	SDG 4. Quality education
Governance by research	Aligning engineering education for sustainable development	To influence engineering-education policy	All 17 SDGs
Governance by conferences	International exchanges on engineering education	Provide a platform for global network to promote engineering education	SDG 4. Quality education SDG 17. Partnerships for the goals
Governance by knowledge services	Bridge the gap on regional engineering capacity	Promote the quality of engineering education in developing countries	SDG 10. Reduced inequalities

Governance by the idea of a global engineering-education community focuses on the international cooperation over engineering education, which is correlated with SDG 17. It aims to promote the development of engineering education worldwide through strong global partnerships and cooperation. ICEE calls on international organizations, governments, universities, enterprises, industry associations, engineering-education researchers and other stakeholders to build the global engineering education community together.

Governance by standards aims to lead engineering-education reform and innovation, which corresponds closely with SDG 4. The key objective of the standard revision work is to ensure that the new GAPC reflects contemporary values, such as sustainable development, diversity and inclusion, and ethics, and employer needs, as well as equipping the engineers/technologists/technicians of the future with the skills to incorporate the practices that advance the UN Sustainable Goals. The field of engineering education will be changed accordingly to meet the requirements of the new GAPC. This will include, for example, developing new pedagogies, such as problem-based learning, project-based learning, context-based learning, and challenge-based learning to support engineers' role in building a more sustainable and equitable world.

Governance by accreditation stimulated the reform of engineering education in China. This form of governance meets SDG 4. Student-centered and outcome-based education models are adopted in shaping a new version of the development of engineering education in China. Increasing numbers of majors passed the accreditation, which indicates that the quality of engineering education in China is improving continuously and that the internationalization of engineering education is heavily promoted. The international recognition of China's engineering education will motivate the mobility of its engineers overseas.

The objective of governance by research is to align engineering education for sustainable development, which can meet all 17 SDGs. ICEE commits to embedding the SDGs into its research projects. For example, in the second UNESCO engineering report project, ICEE proposed to UNESCO to add a sub-chapter to chapter 5 to reflect increasing interregional trends in engineering and to call for more future interregional cooperation for SDGs. The research projects funded by the Chinese Academy of Engineering focus on a wide range of topics within engineering education and sustainable development. Examples include: "Research on the Demand for Engineering Science and Technology Talents and the Reform Strategy of Education Mode for Sustainable Development in the New Era", "Talent Training Mode and Strategy in Key and Core Fields, such as AI.", "Engineering Education and International Cooperation in Post-Pandemic Era: Challenges and Countermeasures", "Database Construction for Engineering Education Development", "Training Strategy of Engineering Science and Technology Talents under the Carbon Peaking and Carbon Neutrality Goals", etc. These research projects are the basis of evidence-based policy making in engineering education in China.

Governance by conferences focuses on international exchanges on engineering education. It aims to support SDG 4 and 17 by enhancing mutual trust and expanding consensus though dialogue and consultation. The theme of the conferences held by ICEE is improving engineering-education quality and sustainable development. These conferences feature extensive numbers of participants. For example, the first international forum on engineering education was held in 2018, and its theme was "Innovation and Development of Engineering Education"; it focused on the Fourth Industrial Revolution and the innovative developments in engineering education in response to global challenges. More than 150 experts, scholars, and industry representatives from well-known universities, international organizations, academic groups, and enterprises from nearly 20 countries or regions participated in the forum [38]. The second international forum on engineering education was held in 2020, with the theme of "Environment and Sustainable Development", which included topics related to water ecology, climate change, health, sustainable technologies, and engineering education for sustainable development. A total of 1364 participants from 25 countries or regions and 38 institutions participated in the second forum [39].

Governance by knowledge services aims to bridge the gap on regional engineering capabilities, which will be helpful to achieve SDG 10. Based on the knowledge-services platform, ICEE provides micro-diploma online-learning projects for international engineering students from developing countries. Micro-diploma learning refers to a series of online courses that focuses on a certain professional theme; learners can obtain a certification in the form of a short-term project by passing exams based on the courses. From 2017 to 2020, 3,000 learners participated in the micro-diploma online-learning project, and 200 learners

passed the exam and obtained the certification. A survey showed that the micro-diploma online-learning project was implemented well and that the international engineering students achieved expected learning outcomes, such as professional knowledge, improved problem-solving abilities, critical thinking, and innovation [40]. Although COVID-19 has led to the closure of large numbers of educational institutions for learners worldwide, this online learning project contributed a significantly to ensuring the sustainability of learning during the pandemic. This kind of high-quality education-resource-sharing bridges the gap in engineering capacity between developed countries and developing countries, which meets the goals of sustainable development.

3.3. The Key Mechanisms of Governance Actions and Challenges

The case analysis shows that collaboration is the key mechanism of global engineering educational governance. ICEE, as a high-level collaboration platform, has built a strong partnership that involves international organizations such as UNESCO and IEA, universities such as Tsinghua, academic consulting institutions such as CAE (Beijing, China), and companies such as XuetangX(Beijing, China). For example, the "Engineering for sustainable development" research project is not only a major academic achievement completed by ICEE in cooperation with UNESCO, but also a successful case of international cooperative research. The report was written and edited by more than 40 authors and multiple editors from over 30 international organizations and universities. The UNESCO Engineering Report is also a key strategic consulting research project of the CAE, with the participation of more than 10 CAE members.

These partnerships have their own advantages in the implementation of the SDGs. International organizations have a natural special-identity advantage. They exist beyond countries but also have close relationships with countries. They represent common human values and interests. International organizations play a key role in promoting the realization of the SDGs. For example, they support Member States in implementing the SDGs, as in UNESCO's action framework and platform for cooperation to promote international cooperation among the 193 Member States. UNESCO's five functions are as a laboratory of ideas, a setter of standards, a builder of capacity, a promoter of international cooperation, and a center of information exchange.

Universities also perform multiple functions, such as talent training, scientific research, social contributions, cultural inheritance and innovation, and international exchange and collaboration, that can provide knowledge and solutions for the implementation of the SDGs. Universities have an unshrinkable responsibility and should become leaders in a sustainable society. Tsinghua University, as a leading engineering university in China, commits to promoting sustainable development, and the implementation of the SDGs in Tsinghua University has achieved remarkable results. For example, in 2020 alone, there were 2317 courses, 20,665 campus events (lectures, workshops, exchanges, and other activities), 408 training projects with 55,557 trainees, and 10,059 patents related to the SDGs at Tsinghua University. Through XuetangX, high-quality engineering-education resources are shared with the entire country, and even the whole world. XuetangX features 62 million registered users and more than 3000 MOOCs. The courses that Tsinghua University provides for XuetangX cover all 17 SDGs.

Companies and engineering education have strong connections with each other. Companies, as employers, have the power to shape engineering education. They contribute to integrating sustainable development into the process of talent training. The China Academy of Engineering is an academic advisory institution for the government, and it has a powerful influence on policymaking. It can also contribute knowledge to the exploration and construction of a new model of global governance. The SDGs are committed to mobilizing the concerted action of multiple subjects to achieve common goals. The strong multilateral partnerships among international organizations, universities, companies, and other parties are the cornerstone of their collaboration. This is the key to achieving multi-agent synergetic governance.

However, collaboration, as the key mechanism of global engineering educational governance, is facing challenges. The diversified partnerships make it difficult to coordinate interests and different opinions, especially when national interests are involved in an international context. For example, there was a problem of map labels concerning territorial integrity in the second UNESCO engineering-report project, and it took significant time for the research team to solve it by using alternative figures to present their findings. When collecting global engineering-education data for the database construction, the problem of missing and inaccessible data arises. The emergence of COVID-19 has led to severe constraints on international exchange and collaboration broadly. As stated in ICEE's research reports, the epidemic will change the world structure and international situation; the competition in science and technology between countries is becoming tougher, and the mobility of international students in the science, technology, engineering, and mathematics (STEM) fields is restricted much more than before.

4. Discussion

There is a good range of typologies of global engineering educational governance for sustainable development. Overall, whether it is the proposal of the concept of an international engineering education community, the formulation of engineering education standards and the accreditation of engineering-education quality, research that serves evidence-based engineering-education policy making, conferences that provide platforms for cooperation network, or knowledge services aiming to bridge the global engineering-education development gap, the objective of these governance actions is to achieve the 17 goals of sustainable development by reshaping engineering education.

The governance activities discussed in this study can be divided into two categories. One is formal governance, which includes governance by standards and accreditation. The other is informal governance, which comprises governance by ideas, conferences, research, and knowledge services. Formal governance contributes to reshaping global engineering education through rules made by international organizations, and it requires governor to be official members of the accord or the agreement. Formal governance has a direct impact and greater binding force on the future development direction of engineering education and the improvement of engineering-education quality. Compared to formal governance, informal governance is an indirect approach to influencing the development of engineering education, which is also called soft governance or flexible governance. However, these governance activities face challenges to their implementation. For example, formal governance by standards and accreditation causes issues in the combination of internationalization and localization. Regulative and normative institutional pressures influence the decisions of engineering schools by requiring them to take visible action to demonstrate their conformity with global norms, while still pursuing local missions [41]. Informal governance by research faces the challenge of how to improve the mobility of scientific knowledge to expand its influence on policy making.

Diversified governance implies complex engineering-education issues and reflects the connections between the SDGs goals. It requires that entities adopt comprehensive and coherent strategies to deal with these issues. The governance activities described in this paper have different focuses. Governance by the proposal of building a global engineering-education community emphasizes the importance of collaboration in aligning engineering education and sustainable development. Governance by standards and accreditation introduces sustainable development into the assessment of engineering education quality and enhances the mobility of engineering students or engineers all over the world. Governance by research places particular emphasis on providing evidence for engineering-education policy makers. Governance by conferences stresses communication and information exchange in shaping engineering education. Governance by knowledge services focuses on higher-quality engineering-education resource-sharing. All these governance activities form a close governance network, which aims to deal with engineering educational issues precisely.

The case suggests that ICEE is an active participant in global engineering-education governance. This role is rooted in the following facts. China has promised to take the post-2015 development agenda as its mission, and work with others to promote global development. To guide and promote the implementation of the SDGs, China has formulated and issued a series of guidelines and policies to achieve the goals of sustainable development, which has included the following actions: issuing China's National Plan on the Implementation of the 2030 Agenda for Sustainable Development; the implementation of the SDGs has been embedded in the 13th Five-Year Plan, the 14th Five-Year Plan, and the national medium and long-term development strategy; and the Scheme of Constructing Innovation Demonstration Zone for implementing the 2030 Agenda in China was issued, and the Zone was established. As a responsible large developing country and a permanent member of the United Nations Security Council, China will stay committed to the implementation of the SDGs and integrate sustainable development not only with local development, but also with global development. China will always be a builder of world peace, a contributor to global development, and a defender of the international order. In this context, China, as an important participant, plays an active role in the global engineering educational governance [42]. The governance activities described in this research indicate that China has multiple roles in global engineering-education governance. These roles include the development of engineering education worldwide, contributing new approaches to the development of global engineering education, defending international engineering-education standards and rules of accreditation, providing high-quality engineering-education resources for the whole world, and constructing a collaboration-and-exchange mechanism for developing partnerships in engineering education.

The acceleration of the progress toward achieving the SDGs all over the world is the significant effect of ICEE's participation in global engineering-education governance. ICEE's governance activities meet the expectations of the commitment to implementing the SDG-acceleration actions, which were proposed at the 2019 SDG summit. Because of the COVID-19 pandemic, t progress towards the SDGs has slowed and become more challenging, according to the 2020 and 2021 SDG progress reports. The global community needs to unite more than ever and develop strong partnerships to ensure that no one is left behind. This is why China has to participate in global engineering-education governance. The experience of ICEE's participation shows that the multi-agent synergetic governance model, which involves international organizations, universities, companies, academic consulting institutions, and other entities, could enhance governance efficiency by developing a comprehensive and coherent strategy. Although this model of collaboration is facing challenges, this multi-agent synergetic-governance model provides a new path for building partnerships and accelerating progress toward the SDGs.

5. Conclusions

This research presents the image of China's participation in global engineering-education governance by mapping the governance activities of a typical case: ICEE. There is a good range of typologies of global engineering-education governance for sustainable development. The impact of ICEE's participation proves that the multi-agent synergetic governance model could enhance governance efficiency by designing a comprehensive and coherent strategy that contributes to accelerating progress toward achieving the SDGs. This research can help the global community to develop a full and deep understanding of China's participation in global engineering-education governance. However, the challenges described in this research have not been solved; this is the limitation of this research. Further research on global governance and the SDGs should address the fundamental imbalance in power and resources between countries [43].

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