


Frameworks for Developing a 6G Communication Network to Intensify the Modern Vocational Education System

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ABSTRACT

A modern technology-supported vocational educational system significantly affects the quality of vocational training and contributes to the innovation and economic development of the regional area. The visualization literature analysis was adopted with the purpose of exploring the theoretical framework for developing a 6G-assisted network to realize the multi-party participation in the modern government-industry-education Integration system. The literature review showed the network should involve all cooperation entities into the communication system to intensify all coordination guided by the triple helix theory, should be strong enough to store all kinds of resources to support the optimized sharing, be efficient to track student training processes and learning data to provide scientific evaluation to student development in personal qualities and competencies, be supportive to develop a cooperating culture to form a healthy ecosystem in which all enterprises actively participate and invest in vocational education.

KEYWORDS

6G Technology, Communication Network, Cooperation, Regional Development, Vocational Education

INTRODUCTION

Modern technology represented by computing technology, artificial intelligence, the Internet of Things, and 5G is being extensively applied in all human activities. The emerging 6G (sixth generation) communication networks, which are characterized by higher speed, increased device connectivity, advanced spectrum use, and lower latency communication, have been drawing attention from all over the world and are expected to be applied widely to teaching and learning.

Many scholars researched learning and teaching from the perspective of psychology and cognitivism regarding the theoretical framework. Constructivism emphasis on the interaction of students' experience with the work environment provides a theory foundation for an enhanced vocational learning and how technology facilitates constructivist learning (Brown, 1998; Doolittle & Camp, 1999; Kerka, 1997; Van Bommel et al., 2012). Rojewski (2009) proposed that a conceptual framework should be based on principles and philosophies that provide schema for some critical issues

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and solutions. The application of cutting-edge 6G technology should be demand driven and user centric (Kasi et al., 2023). Singh et al. (2011) proposed the user-centric technology development in the design and construction industry across disciplines should be emphasized for designing collaboration platforms. This proposal is consistent with the proposal of Liao (2022) that cooperation platforms supported by information technology are more than document management tools. Many deficiencies and inadequacies exist in communication channels and cultural infrastructure in the current system, and the collaboration and cooperation are limited to university-university or university-industry (Demirel & Bayer, 2015). Scholars are more likely to research the information technology in a specific area rather than multiple areas. Few researchers have ever addressed the general principles or philosophies that should be followed when designing a three-sphere cooperation platform spanning multiple disciplines. Taking a literature analysis method, I delve into the conceptualization and development of frameworks tailored for establishing a 6G communication network with the purpose of enhancing the modern vocational education system. This Research elucidates the intricate interplay between 6G communication networks and the modern vocational education paradigm. The interplay comes from five relevant disciplines: triple helix theory, government administration, enterprise administration and production, 6G-assisted vocational teaching and learning, and the application of 6G technology. By exploring the comprehensive frameworks of different disciplines, I aim to enhance the dynamic vocational education ecosystem, thereby fostering an environment conducive to heightened engagement, efficiency, and relevance in the government-university-industry cooperating system directed to the sustainable regional development. This research addresses three questions:

- Q1:** What theoretical framework should be followed when developing a 6G technology-supported government-university-industry integrated vocational education system?
- Q2:** What principles should be followed when designing the functions of the vocational education system?
- Q3:** How can the 6G-assisted vocational education system support the sustainable regional development?

LITERATURE REVIEW

The Theory of the Triple Helix Model

Vocational education plays a decisive role in the economic and social development of a region. It mainly supports regional development by providing highly skilled human resources. Neave (1979) addressed the question of how regional development was influenced by higher educational institutions. He stated that development could not always refer to economic growth, technology progression, and industry advancement, but rather, the presence of higher education institutions accelerates the cultural and industry development, especially when higher education was directed toward higher technology related firms. Promoting vocational education and training has been extensively recognized as a key strategy aiming to accelerate economic growth at the national and regional levels (Rees, 1997). Etzkowitz (2002) created the triple helix model of government-university-industry in which he explained how transformation of knowledge took place by interacting with each other and improving innovation in each sphere. Kearns et al. (2008) proposed the double helix theory that demonstrated the relationship between vocational education and training with regional development; they suggested that vocational education and training should be integrated with the economy of the region by providing the skills needs of the region to achieve the sustainable development. The principle of meeting requirements of industry led to the training curricula, the assessment methodology, the pedagogy, and the administration of vocational education, all of which were voiced by business and industry leaders who guided the transforming of educational goals for institutions, practitioners, and students (Billett, 2004). Kearns et al. (2008) showed that a

highly developed region was signified by a great many businesses centering on a global competitive enterprise, with many active and prospective research and development programs, high skilled human capital forces, and local supportive policies from many perspectives. A productive linkage of economy, society and environment infrastructure and an adequate number of enterprises and institutions that had a strong sense of cooperation were usually presented in a highly developed region. Many scholars advocated that by adopting the clustering approach in spatial distribution, enterprise and educational institutions clustering together in certain areas, such as a vocational education park and a vocational education industry park, could strengthen the integration network of cluster members; support easier access to industry technologies, shared capital, and knowledge resources; and show good spatial reciprocity (Hao et al., 2018; Shaidullina et al., 2015).

Modern Information Technology Used in Government Administration

Research related to modern administration is mainly referred to e-government and modern technology-supported administrative platforms designed to improve government work efficiency, accountability, and data transparency. Previous researches proved the efficiency of message delivery, rich content, and multi-functions of e-government, and have shown how these modern platforms strengthen the government response to on-demand services (Chawviang & Kiattisin, 2022; Chen & Si, 2021; Hu et al., 2013; Pang et al., 2014; Yang et al., 2020). Both statistical and descriptive methods were employed to test the efficacy of e-government service. Hu et al. (2013) adopted the statistic method of the confirmatory factor analysis (CFA) and structural equation modeling (SEM) to test the efficiency of e-government in administration. Pang et al. (2014) used an empirical method to prove that investment in the IT system could save the government expenditures. Novachenko et al. (2020) identified five trends of applying IT in the background of digital transformation in public administration; they believed digital transformation could win more institutional support in public administration and ensure public control over the activity of executive bodies by increasing the accountability and transparency of civil services. Yang et al. (2020) found that information communication technology (ICT) enabled governments to act quickly and efficiently in releasing information to the public in crisis and emergencies. Martins and Veiga (2022) used a panel dataset to demonstrate that innovatively applying information and communication technologies in digital government could effectively reduce administrative and regulatory burdens.

Modern Information Technology to Support Production in Industry

The functions in improving administration and reducing management burdens of IT greatly contribute to the production performance of business and industry. Investments in IT have a positive effect on productivity, specifically referring to profit increase and productivity improvement because of the lower cost in developing, designing, and manufacturing (Moyano-Fuentes et al., 2012; Thatcher & Oliver, 2001). A firm's ICT-supported governance and project governance contributes to firm project performance, which is reflected in the setting of the firm's strategy, the delivery of value, and the management of performance; this will finally increase the success (Sirisomboonsuk et al., 2018). Regarding the interactions among the human capital of firms, research has shown education and IF enhanced the labor productivity (Flaminiano et al., 2020; Shahnazi, 2021). When combined with skilled labor and the knowledge-based interorganizational network, it could improve the innovation capabilities of manufacturing firms (Orozco et al., 2022). The ICT-supported management had a positive impact on improving organizational services, increasing knowledge, democracy, and awareness of participants, all of which enhanced the accessibility and communication between cooperatives and stakeholders (Chawviang & Kiattisin, 2022). Research on information technology-supported management to improve efficiency and performance covered a wide area. Lu et al. (2021) showed that IT advancement contributed significantly to constructing labor productivity, which was a great measure for sustainable development and competitiveness of firms in the construction industry. Saleh et al. (2021) and Bronsoler et al. (2022) tested how ICT-supported communication and documentation

lead to reducing medication errors, enhanced nurse proficiency, and work outcome, thereby benefiting the health care facilities. Subramanian (2021), Twumasi et al. (2021), and Khan et al. (2022) found that improving the access of farmers to mobile technology-supported information release service could improve agricultural productivity. Hwang and Kim (2022) argued that adopting emerging technologies represented by artificial intelligence, big data, and robotics had a positive impact on manufacturing productivity of small and medium enterprises. Mohamed et al. (2022) proved that implementing robotic process automation in human resources management systems supported offering better service and improving productivity.

Modern IT to Support Teaching and Learning

The efficiency of information and communication technology-supported learning, teaching, and administration has been extensively researched and recognized by scholars in education. In the vocational education area, researchers mainly focused on vocational training, resource sharing, and cooperation between industry and education institutions; the digital competency of students and practitioners also drew great attention from researchers. The technology commonly applied in vocational teaching refers to technology platforms support blended learning, resources sharing, student evaluation and cooperation management, and some emerging technologies used to assist course teaching in pedagogy. Applying ICT in vocational college course instruction could motivate students' learning and improve the quality of instruction and the comprehensive learning ability of students, and it also contributed positively to higher quality homework and academic performance. Stefanovic et al. (2021) created a lifecycle model of virtual internships assisted by web-based digital platforms. This model was tested to enable students to gain real position experience and skills in a remote setting by providing access to an internship database, lectures, assessments, and assignments; improving the level of collaboration and communication; and increasing the professional knowledge and skills related to online peer groupwork and collaboration. Roldan-Alvarez et al. (2021) addressed the assistant functions of collaborative learning platforms and mobile devices such as tablet computers; these handheld devices were tested to provide chances for people with intellectual disabilities. They show promise for teaching position-related skills, increasing motivation of students to complete the tasks, and improving their instruction skills. The function of ICT platforms were proved very efficient in data collection and document recording; research showed that these platforms could help vocational students to fit better in work placement positions, enhance the cooperation of enterprise instructors and vocational college instructors, and improve student management in enterprises, all of which contributed to students' training efficacy in work placement (Liao, 2019, 2022).

THE 6G TECHNOLOGY

The emerging technology of the 6G wireless technology has been drawing great interests from many scholars. The possibility and expectations on developing and applying the 6G technology beyond the fifth generation paradigms have been extensively discussed. Nawaz et al. (2019) first envisioned the 6G as a massively connected complex network that can respond rapidly to users' requirements. Applying artificial intelligence and machine learning techniques in 6G enables the network to support faster broadband, provide more massive access, and be more reliable (Du et al., 2020); to realize lower latency services (Barakabitze & Walshe, 2022; Ugwuanyi et al., 2023); and to provide higher capacity, lower cost, and higher satisfied services (Barakabitze & Walshe, 2022). Imoize et al. (2021) addressed the multifaceted communication capabilities of 6G from the perspectives of technology-driven challenges and the probable solutions to them; they predicted that the new technology would contribute significantly to global sustainability and bring dramatic changes in all areas of the society, including education.

My literature review concluded that the application of modern ICT in government administration, industry production, and educational activities is extensively proven and recognized by scholars.

Researchers delving into ICT in vocational education usually focused on a specific emerging technology used in a certain course instruction and instruction resources sharing, whose target population would be students or practitioners in vocational education. The platforms used to support communication and management mostly involve students and their practitioners, who are the instructors from higher vocational institutions (i.e., vocational high schools and tertiary vocational colleges). Instructors from enterprises and administrators from educational government departments, two groups of important providers, are not included in existing platforms (Demirel & Bayer, 2015; Liao, 2022). Research covered vocational education directed at regional development focusing on the spatial clustering and cooperation among members (Akgis Ilhan & Karakas, 2021; Chen & Ye, 2021; Hao et al., 2018; Jones & Henderson, 2019). However, no researchers have ever addressed the ICT platforms designed to strengthen the cooperation among multiple parties of government departments, educational institutions, and enterprises at the same level. The exploration of application of 6G technology has not reached the area of vocational education collaboration, which left enough possibilities for exploring the theoretical framework with the guiding theory of triple helix. For this study, I employed a literature analysis approach to examine relevant literature across distinct disciplines comprehensively. The aim is to identify the disciplines and philosophies that should be considered when developing a management platform supported by 6G technology, with the ultimate goal of fostering improved cooperation and collaboration among vocational educational entities. The emphasis on user demand and a user-centric approach will be more effectively upheld by incorporating all collaborating entities into the management system.

METHODS

Research Design

I adopted the triple helix as the fundamental theory to carry out a literature analysis to explore the theory framework of developing a modern ICT platform, where at least three parties (i.e., the local government, educational institutions, and enterprises) can be involved in the integration of a vocational education system to achieve continuous regional development by providing industry needed skilled human resources. CiteSpace is a powerful tool for researchers and academics to do literature analysis. Many scholars (Cui et al., 2018; Ding & Yang, 2022; Guo et al., 2022; Okolo et al., 2023; Rawat & Sood, 2021) have used it to provide a general map of the intellectual structure of a field, track the development trend of research themes, find the potential collaborators, identify the research gaps, and demonstrate the results in statistic and visualized way (Chen, 2006, 2016). By identifying hotspots, analyzing networks, and identifying bursts of keyword use, the software helps researchers identify the research hotspots and understand the relationships and the structure of scholarly communication, indicating periods of increased interest in specific topics (Chen, 2014). With the support of CiteSpace 6.1.R2, I first visually analyzed the existing literature about the 6G technology to find out the main characteristics in application. In the second step, I explored the guiding theory of triple helix applied in vocational education and training. In the third step, I used the same method in analyzing the principles when developing a 6G technology-assisted vocational educational and management system. Then, I analyzed how and through which functions the new ICT of 6G supports the continuous regional development. Lastly, I examined how the 6G-supported management system supports the cooperation and integration of multiple parties in the vocational ecosystem. After demonstrating the keywords and hotspots in the five areas, I made a comprehensive analysis on the theoretical framework and principles that should be followed when designing the 6G-assisted management platforms.

Data Resources

My research took the literature indexed in databases of Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), and Arts & Humanities Citation Index (AHCI),

the three core databases indexed in the Web of Science, as the original data for analysis. These databases index the leading scholarly journals of the natural and physical sciences, social science disciplines, and arts and humanities.

Data Analysis

The Core Technology in Developing a 6G Network

For the characteristics and application of a 6G network, I searched documents by setting the search condition as “title with ‘6G’ + all fields with ‘network’ + all fields with ‘multi.’” I obtained 196 papers in the database on November 29, 2023. I set the time slicing from January 2019 to November 2023, chose “Pathfinder” and “Pruning the merged network,” and all other term sources as listed in the processing panel of the analyzing software. I chose “Keywords” as the node type, set the threshold of 4, and chose keyword as the source to label clusters. The visualization map of analysis showed 187 networks of the keywords and 428 relationships between keywords. The CiteSpace software analysis vividly shows the hot topics of 6G to support communication. The detailed frequency of keywords is presented in Table 1, and the visualization of keywords and the label clusters with the abstract terms is shown in Figure 1.

THE GUIDING THEORY OF TRIPLE HELIX APPLIED IN VOCATIONAL EDUCATION SYSTEM

Using the Core Collection of Web of Science and the same other conditions as the data source, I searched documents by setting the search condition as “title with ‘triple helix’ + all fields

Figure 1. Keywords and label clusters related to 6G technology



Table 1. The frequency of the top 20 keywords with the abstract terms

No.	Fre.	Keywords	No.	Fre.	Keywords	No.	Fre.	Keywords
1	58	6g mobile communication	8	19	Artificial intelligence	15	13	Wireless communication
2	29	Networks	9	17	Systems	16	12	Architecture
3	27	Challenges	10	16	5g mobile communication	17	12	Design
4	24	Resource allocation	11	15	Communication	18	11	Computational modeling
5	24	Resource management	12	15	Task analysis	19	11	Optimization
6	20	5g	13	13	Wireless networks	20	11	Quality of service
7	19	Internet	14	13	Vision			

with ‘vocational education’ + all fields with ‘industry.’” When the document type was refined to articles, 34 papers were obtained in the database on November, 29, 2023. The CiteSpace software analysis vividly shows the hot topics of triple helix applied in the vocation education system. After setting the time slicing from January 2013 to November 2023, I created other settings for the analysis on the 6G network. The visualization map of analysis showed 152 networks of the keywords and 529 relationships between keywords. The density was 0.05. Ten keyword label clusters were found when I chose the abstract terms. The detailed frequency of keywords and cluster names are listed in Table 2, and the visualization keywords and cluster map are shown in Figure 2.

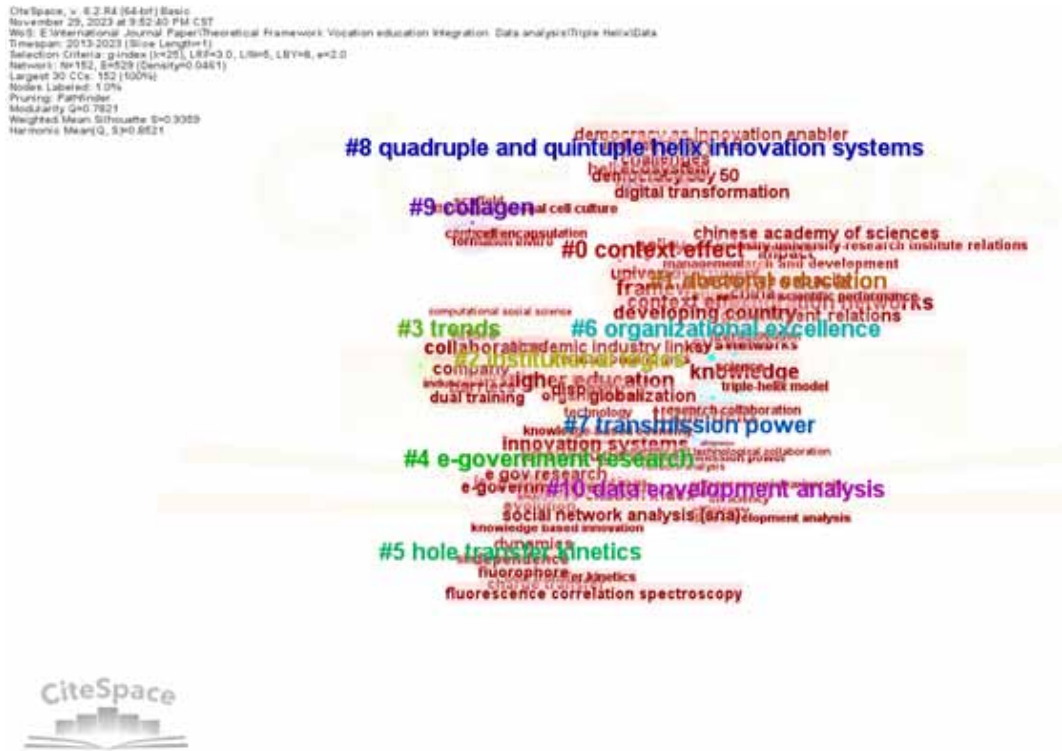
THE PRINCIPLES TO FOLLOW WHEN DEVELOPING 6G-ASSISTED VOCATIONAL EDUCATION MANAGEMENT SYSTEMS

Setting the search filter as “all fields with ‘vocational education’ + all fields with ‘cooperation’ + all fields with ‘enterprise’” to search articles in the Web of Science Core Collection, I refined the document type to articles, review articles, and early access articles. After removing one retracted study, I obtained 60 papers from the database on November 29, 2023. When I

Table 2. The frequency of the top 20 keywords related to the triple helix theory

No.	Fre.	Keywords	No.	Fre.	Keywords	No.	Fre.	Keywords
1	17	Triple helix	8	4	Research and development	15	3	Government
2	9	Systems	9	4	Industry	16	2	Triple helix model
3	6	Policy	10	3	Performance	17	2	University-industry-government collaboration
4	6	Knowledge	11	3	Science	18	2	Innovation systems
5	5	Technology	12	3	Institutional logics	19	2	Knowledge base
6	5	University	13	3	Networks	20	2	Impact
7	5	Innovation	14	3	Organizations			

Figure 2. Keywords and label clusters related to the triple helix theory with the abstract terms

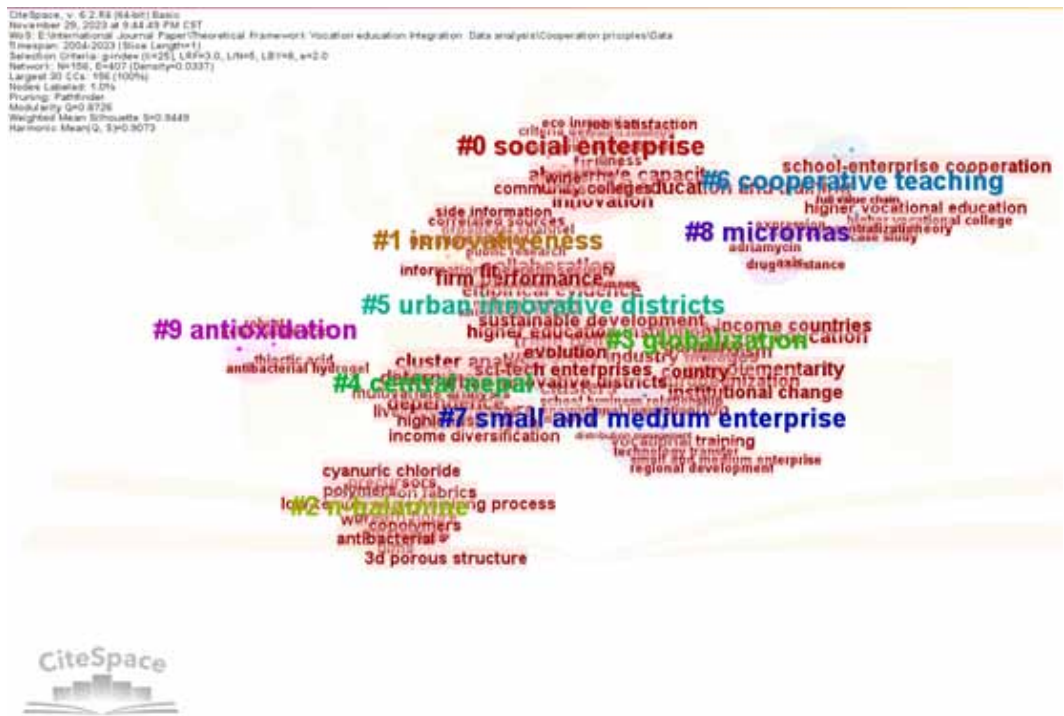


set the same conditions in the control panel as in the previous analysis, 156 networks, 407 relationships, and nine keyword label clusters were found. The density was 0.03. The detailed keywords frequency is presented in Table 3, and the visualization map of keywords and clusters is shown in Figure 3.

Table 3. The frequency of the top 20 keywords related to principles

No.	Fre.	Keywords	No.	Fre.	Keywords	No.	Fre.	Keywords
1	4	Education	8	2	Collaboration	15	2	Industry-education integration
2	4	Vocational education	9	2	Complementarity	16	2	Innovation
3	3	School-enterprise cooperation	10	2	Determinant	17	2	Network
4	3	Vocational education and training	11	2	Enterprise firm	18	2	Performance
5	2	Absorptive capacity	12	2	Higher vocational college	19	2	Science
6	2	Austria	13	2	Higher vocational education	20	2	State
7	2	Cluster	14	2	Impact			

Figure 3. Keywords and label clusters related to the triple helix theory with the abstract terms



THE ICT-SUPPORTED REGIONAL DEVELOPMENT

After setting the search condition as “title with ‘ICT’ + all fields with ‘regional development,’” I refined the document type to refine articles and review articles. I obtained 59 papers from the database on November 29, 2023. I then set the same conditions in the control panel as in the previous analysis. A total of 296 networks and 765 relationships between keywords were found with the density of 0.02. The keywords of frequency are listed in Table 4, and the keywords and label clusters visualization map is shown in Figure 4.

HOW DOES THE ICT PLATFORM SUPPORT COOPERATION AND INTEGRATION?

After setting the search condition as “all fields with ‘ICT’ + all fields with ‘education and training’ + all fields with ‘functions’ + all fields with ‘design’” in the same databases, I retrieved 70 papers from the database on November 29, 2023. When the same analysis conditions were set in the control panel as in the previous analyses, I found 221 networks between keywords and 520 relationships. The density was 0.02. The keywords of frequency are listed in Table 5. The keywords and label clusters with abstract terms are shown in Figure 5.

DISCUSSION

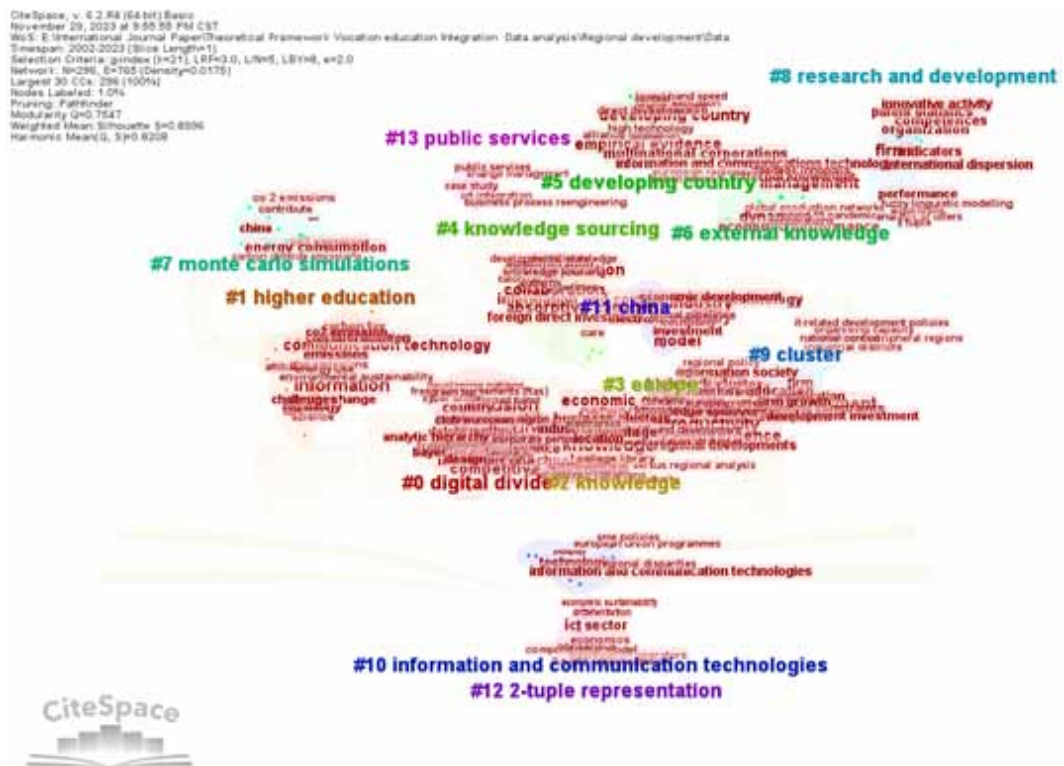
The Guiding Theory for Developing a Modern 6G Technology-Supported Vocational Education System

With regard to the question of which theoretical framework should be followed when the 6G technology-supported vocational education system is being developed, the analysis results show that

Table 4. The keywords frequency of the ICT-supported regional development

No.	Fre.	Keywords	No.	Fre.	Keywords	No.	Fre.	Keywords
1	25	Innovation	8	10	Technology	15	7	Regional development
2	22	Information	9	10	Impact	16	7	Internet
3	16	Research and development	10	8	Clusters	17	7	Networks
4	14	Economic growth	11	8	Knowledge	18	7	Energy consumption
5	11	Communication technology	12	8	co2 emissions	19	7	Growth
6	11	Digital divide	13	7	Information and communication technology	20	6	Productivity
7	10	Adoption	14	7	Firms			

Figure 4. Keywords and label clusters with abstract terms of the ICT-supported regional development

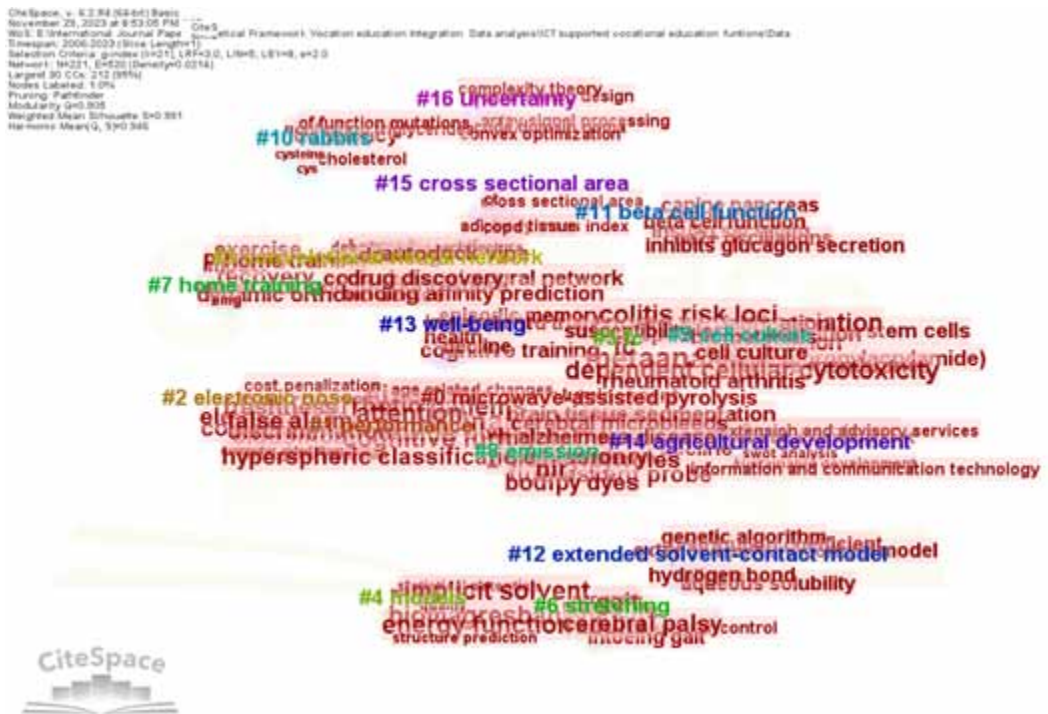


the triple helix theory is applied widely, and it's the guiding theory in practice in the international world to support the economic and regional development. This theory covers the collaborative relationships of three parties: academic institutions, industry, and government (Etzkowit & Leydesdorff, 1995). It demonstrates sustained interactions between educational institutions and the industry, and these interactions act as an engine to the knowledge-based innovation, economic development, and societies

Table 5. The keywords frequency of the ICT-supported vocational education and training

No.	Fre.	Keywords	No.	Fre.	Keywords	No.	Fre.	Keywords
1	7	Design	8	2	Deep reinforcement learning	15	2	Cognitive training
2	3	Deep learning	9	2	Deficiency	16	2	Disease
3	3	Performance	10	2	Network	17	2	Upper extremity
4	3	Algorithm	11	2	Recovery	18	2	Meta analysis
5	2	Task analysis	12	2	Neural networks	19	1	False alarm
6	2	Neural network	13	2	Activation	20	1	Cell culture
7	2	Classification	14	2	Barriers			

Figure 5. The keywords and label clusters with abstract terms of the ICT-supported education and training



(Etzkowitz & Leydesdorff, 1995; Leydesdorff & Etzkowitz, 1996). As shown in the keyword frequency and clusters, this model focuses on the collaboration and communication of three parties and the innovation power for societies. When applied to vocational education, it emphasizes the firm performance and competencies of students or trainees. The integration model was introduced in China in the late 20th century, and it drew great attention of researchers in academia, especially in education. After setting the topic of “triple helix’+ ‘vocational education” in the search panel of China National Knowledge Infrastructure (CNKI), the largest key national e-publishing project of China, I obtained 1,234 documents of journal documents or dissertations on November 29, 2023. The triple helix approach was tested to be at the core of success in vocational education (Coletti, 2019). Along with the dual apprenticeship system, it has become one of the guiding theories for the

vocational education system in China. In the Chinese vocational education system, the government works as the harmonizer and stimulator for the research-industry integration by offering incentive policies on financial possessions and land planning; the industry provides internship and apprenticeship positions for students from vocational institutions and offers support in other student training processes. Under this system, educational institutions also adjust the programs and curricula to cultivate the labor resources to meet requirements of modern production. However, in past decades, the industry performance in this vocational training system is quite limited, and vocational educational institutions are excelling to attract enterprises and industry associations to get involved in vocational training. To promote the integration and to intensify the awareness of cooperating with three parties to develop the consciousness that they share the same destiny in future development, the “vocational educational community,” consisting of government organizations, educational institutions, and industry, was coined after Chinese President Xi Jinping proposed the theory of “a community with the shared future of mankind.” To follow the basic principles of using a user-demand and user-centric approach, the triple helix should be taken as the guiding theory when designing the 6G management system to support multi-entity collaboration.

THE PRINCIPLES FOR DEVELOPING A MODERN 6G TECHNOLOGY-SUPPORTED GOVERNMENT-INDUSTRY-EDUCATION INTEGRATED VOCATIONAL EDUCATION SYSTEM

Five principles should be followed when developing the 6G technology-supported government-industry-education integrated vocational education system. As the analysis results show, the literature in this area focuses on the clustering in geography locations of different types of institutions, the complementarity in resources, the collaboration and performances between two main bodies of educational institutions and enterprises, the impacts to students’ competencies, the formation of the integration network, and the driving force to innovation. Applying a modern communication system to vocational education reform is the precondition for modern intelligent manufacturing in which the participation enthusiasm and implementation motivation of enterprises are critical to the cooperation efficiency (Ji & Li, 2021). The cooperation among government institutions, enterprises, universities, or colleges to the regional economic development can be divided into three phases: knowledge interaction, creation, and application. Support to vocational educational entities can improve the management competencies of an enterprise in the future and benefit the whole labor market (Szafranski, 2022). The innovation in educational institutions is highly related to the development of sci-tech enterprises (Wu et al., 2020). The partnership benefits educational institutions by maintaining the sustainable development of them, improving the quality of vocational education and training, optimizing the learning processes of students, obtaining support and assistance from the industry to develop and implement programs at vocational schools and colleges (Mahmudah et al., 2022), improving students’ employability (Ma, 2020), and favoring the faculty training in vocational curriculum.

However, there are significant discrepancies between graduates and requirements of employers owing to barriers in the cooperation in which enterprises show low readiness in the interaction on building a modernized technical base, providing internships for instructors, and investing in educational programs (Borodiyenko et al., 2021). Moreover, educational institutions can’t fully involve enterprises in curricula development, advising on establishment of educational programs, participating educational process reflected by industry required methods and technologies, updating educational equipment, and providing supports to instruction materials (Borodiyenko et al., 2021). The coordination of education, production, research, and training can be strengthened by adopting unified technologies and equipment; applying IT or a knowledge management system can reduce the cooperation barriers brought by physical platforms. The quality of vocational education can be improved by optimizing the resources sharing and interests of schools, colleges, and enterprises through building information

communication platforms to intensify government industry associations; expanding education and industry connection; and discussing the content and methods of cooperation could improve the quality of vocational education (Yang, 2018). The current information platform applied in education is strong in releasing work placements from enterprises, but weak in monitoring students' training processes and evaluation. Developing a more supportive system to facilitate communication between enterprises' supervisors and directors from the vocational college is urgently to be designed (Liao, 2022). According to the triple helix theory and the literature analysis, developing a modern information system supported by 6G technology to a facilitated vocational education system should follow the five principles discussed in the next section.

Be Inclusive With Cooperative Parties

Involving all cooperating bodies in vocational education is the basic principle that the modern IT communication network should follow. Enterprises and vocational educational institutions are the two main bodies in education-industry interaction. Specifically, people representing these bodies refer to supervisors and administrators of the business who instruct students directly and indirectly on work placements, instructors and administrators of students from schools or colleges. Administrators from the government educational department should play an important role as stimulator, planner, and harmonizer in the interaction of different entities. Students who receive the education and training in the system are the center to whom all parties provide service, and they are the main users in the platform. Industry associations who can provide evaluations and professional certificates are involved in the platform to ensure the quality of training and the efficacy of coordination of all parties in the system. Designing channels in the platform to support effective enterprise-students-education interactions is critical to the ICT-supported modern vocational system.

Be Supportive in Optimized Resource Sharing

Optimizing the sharing resources of many parties who participate in education and industry is the foundation on which cooperative relations can be established. Educational institutions train high-skilled labor to serve the modern production, and the industry supports the training to help self-development by obtaining innovative sources. Research showed that a very low percentage of enterprises are satisfied with the graduates' professional competencies and personal qualities; the reason is that these graduates can't work on equipment used at the enterprise because the training they received is on outdated materials and equipment in the training base (Borodiyenko et al., 2021). Resource storage and sharing would be one of the main functions that the communication network should develop. Resources include government planning and vocational educational policies; land and financial stimulators; regulations for institutions and enterprises; teaching resources, such as curriculum, instruction videos, training equipment, and technologies; and investments in modern vocational industry colleges in the vocational system. In the real or virtual professional work environment, human resources who provide training are resources in different forms that could be stored and shared and transformed from machine to machine as data.

Be Efficient in Tracking Training Processes

Because of the limitations of training locations, mainly caused by the special characteristics of vocational education, student training, including workplace learning, is conducted out-campus and primarily by enterprise instructors. However, the student evaluation and certification are coordinately made by enterprises, colleges, and industry associations, and even other third-party evaluation institutions. Tracking the training processes and keeping students' learning data can support scientific evaluation, thus benefiting students' professional development. Out-campus training brings barriers to instructions of the education institutions and students' training tracking in enterprises.

Be Strong in Assisting Communications

Providing communication channels for all entities in vocational education is one of the basic functions of the 6G communication network of vocational education. The network could support the participating entities to cooperate timely and effectively in the complex system. The communication covers several layers, including instructor-student interaction in which instructors refer to both advisers from the school and supervisors from the enterprise; other complex communications include coordination of government-education-enterprise, colleges-enterprises, students-enterprises, colleges-colleges, and communications between the training staff of the enterprise and the college. This is similar to the suggestion of Liao (2022), who presented an empirical research study on designing a communication network for more effective cooperation.

Be Supportive in Developing a Cooperating Culture

The deep involvement of enterprises in student training significantly improves the quality of vocational education and drives the innovation of the work force. At present, enterprises showed comparatively low interest and motivation in participating in the education-industry cooperation (Borodiyenko et al., 2021), and government can't optimize its function in top planning and resources balancing in city development. Developing an ecosystem in which all entities play an active role and are willing to involve each other in the whole training process and invest in the vocational education bases is urgent. The 6G network should be inclusive enough to involve a large number of enterprises and businesses into the system and facilitate them to recognize the short- and long-term benefits of participating in vocational education to form an ecosystem in which all enterprises are ready to advise on training curricula. This ecosystem provides internship positions for students and staff training, improves the training material and equipment, and invests in the vocational base. And the multi-party cooperation involved in this ecosystem covers the whole process of vocational education.

ESTABLISHING THE 6G TECHNOLOGY-ASSISTED VOCATIONAL EDUCATION SYSTEM TO SUPPORT SUSTAINABLE REGIONAL DEVELOPMENT

Modern city development usually refers to the topics of intelligent and sustainable development, knowledge economy, innovation, infrastructure, and management. A vocational educational system serves the regional and national development by providing the highly skilled human capital to support economic advancement and modern manufacturing. Just as Lavia et al. (2021) proposed, the achievement of cooperation of vocational education and enterprises depends on an established culture of innovation of small business, which eventually contributes to the sustainability of economy and society, and overlaps with the goals of the United Nations for sustainable development. Lv et al. (2022) suggested that educational institutions make changes to their training model, including the curricula system, the organization structure, and the innovation ecosystem, to promote the regional development and social progress. Inference could be made that cutting-edge technologies are mainly referred to as big data, mobile applications, internet of things, artificial intelligence, and machine learning, all of which are basic paradigms that support the 6G communication network. These cutting-edge technologies contribute significantly in developing a communication network to support the vocational education system to intensify the partnership to develop the full potential of enterprises in talent training, removing all possible barriers in communication, and setting up an ecosystem for optimized resources sharing.

CONCLUSION

With the purpose of finding the theoretical guiding theory and principles when developing a 6G technology-supported vocational collaboration and management system to support the government-

university-industry ecosystem and regional development, I adopted the visualized and statistic method to analyze the existing literature that is widely accepted by researchers. A conclusion could be made that the triple helix theory was the leading theory in vocational education for the past decades (i.e., to be a user-demand and user-centric approach), and it should be the golden rule for developing the 6G technology management systems. Five principles should be followed to assist the cooperation in vocation education and innovation in a regional collaboration and cooperation ecosystem. First, the network should include all cooperating entities, including government departments, enterprises, education institutions, instructors, assessment institutions, and students. Second, the network should be efficient to store various resources and to realize ultra transmission so that all parties can share resources via the network, which is the foundation on which cooperation relationships can be established. Third, it should be supportive in tracking student learning data and recording student training processes so that the scientific evaluations can be made to student professional competencies and other qualities. Furthermore, the network should be efficient in multi-user communication. Lastly, be supportive in developing a cooperative culture. All developing principles and characteristics of a 6G technology-assisted vocational system are directed to a sustainable development supported by a modern industry and education integration system that relied heavily on innovation of enterprises and society advances. However, these conclusions are drawn on the existing literature about the triple helix theory, 6G technology, education and regional development, and therefore, limitations of this research were inevitable. Further empirical research may prove the conclusions and have more findings in other formats.

CONFLICT OF INTEREST

The author of this publication declares there is no conflict of interest.

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