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An Abibliometric Study of PPP Articles Published in Foreign and Domestic Journals

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Abstract: Research on this issue has garnered a lot of interest worldwide because to the extensive use of PPP in the building industry. To better grasp the research trend in different settings, it may be helpful to do a critical literature study and compare the findings from China with those from other nations. Using CiteSpace's visual map analysis, we combed through 2,399 pieces of PPP literature published in Chinese and international journals between 2008 and 2018. We looked at things like publication frequency, keyword clusters, keyword citation bursts, core institutions, and authors. The primary results are: (1) During the studied period, the total volume of PPP literature increased by an average of 33.09%. Furthermore, compared to foreign journals, Chinese journals published about five times as many articles. The international literature on public-private partnerships tended to centre on topics pertaining to project management, while the Chinese literature tended to centre on funding. (3) Institutions in China did not work as closely together as those in the international PPP research community. (4) In international papers, the teams headed by Mr. Jia from the Chinese Academy of Financial Sciences and Professor Chan from the Hong Kong Polytechnic University are the most prolific contributors from China when it comes to PPP. Research comparing PPP topics from a worldwide viewpoint and investigating how PPP projects might benefit from contemporary technologies to enhance management performance were also proposed.

Keywords: CiteSpace; PPP; Visual Map; Chinese; Comparative Analysis

1 Introduction

According to the China National Development and Reform Commission (2014), public-private partnerships (PPPs) are partnerships between the government and social capital that aim to increase the efficiency and effectiveness of the supply of public goods and services. These partnerships involve benefit-sharing, risk-sharing, and long-term cooperative relationships. There were 9,299 projects of RMB 14175.9 billion invested in the database of the China Public Private Partner Centre (CPPPC 2019), according to the figures. On March 11, 2019, the Ministry of Finance of China released the Implementation Guidelines on Promoting the Regulative Development of Partnership between the Government and Social Capital, one of several policies issued by Chinese government departments and agencies at different levels to control the growth of PPP. There is a lot of room for growth for the PPP model in the future years, thanks to government support in China and pressing demands in the construction sector.

Applications of PPP have also been very popular on a worldwide scale (Almarri 2018), likely due to the fact that it may reduce the fiscal spending load on the government, increase operational efficiency, and boost innovation. The fast expansion of public-private partnerships (PPPs) both domestically and abroad, and, more crucially, the integration of Chinese and foreign market exchanges and contacts. This means that crucial to examine the commonalities and variations in the comprehension of PPPs. Furthermore, prior studies have shown that a considerable amount of the world's PPP knowledge has originated in mainland China (Zhang et al. 2016; Zhang et al. 2020). However, foreign journals have published a negligible

quantity of PPP research from the Chinese community, in contrast to the vast number of PPP articles in China. As a result, practitioners and researchers from other countries may struggle to comprehend the current state of PPP research in China due to linguistic barriers. Research in Chinese and foreign journals was chosen as the data source to meet the research aim of addressing the gap in this subject. In order to keep academics and practitioners apprised of the progress of PPP knowledge on a global scale, this comprehensive literature analysis compares the research trend and key research institutions/authors in China with those in other countries.

2 Literature Review

The BOT, BT, TOT, DBFO, and BOOT models are among the many available PPP options (Zhang et al. 2016). According to Song et al. (2019), there is a difference in the popularity of the build-operate-transfer (BOT) and private financing initiative (PFI) models among countries. As an example, the PFI model was used to produce 91% of all PPP projects in the UK. Comparatively, BOT was used in 47% of all PPP projects in China and 47% of all projects in India (Cheng et al. 2020). Many other kinds of building projects, including those dealing with transportation, water, waste treatment, and healthcare, have adopted the PPP model because of its inherent advantages (Zhang et al. 2020). Some of these benefits include the following: a reduction in government spending due to private sector innovation and efficiency; a guarantee of on-time project completion; and an incentive for private sector businesses to start operations early in order to earn income (Cheung et al. 2010). But we must not ignore the fact that PPP applications have a number of drawbacks. As an example, public-private partnerships (PPPs) entail high levels of risk, can include several parties with competing interests and goals in the project delivery arrangements, and may be accompanied by a drawn-out and convoluted bidding process (Cheung et al. 2010). Without first-rate project management throughout the application phase, all of these things may cause PPP initiatives to bomb. Given this context, numerous studies have examined the important aspects of public-private partnership (PPP) applications, including funding (Mostafavi et al. 2016; Lu et al. 2019), CSFs (Chan et al. 2010a; Osei-Kyei and Chan 2017), risk identification and allocation (Yu et al. 2018; Yuan et al. 2018), evaluation of performance (Love et al. 2015; Liu et al. 2018; Rohman and Wiguna 2019), legal issues (Muleya et al. 2019), and sustainability (Haavaldsen et al. 2014; Shen et al. 2016). One example is the work of Osei-Kyei and Chan (2017), who examined the use of CSFs in the execution of public-private partnerships (PPPs) in both developing and developed nations. According to the study's findings, sixteen CSFs had differing weights in Ghana and Hong Kong. Political, financial, revenue and market, promotion, procurement, development, construction completion, and operation risks were the eight main categories of project risk outlined by Zayed and Chang (2002). To what extent does the ratio of public to private funding affect the long-term viability of PPP projects? That was the question explored by Shen et al. (2016). One approach to measuring PPP projects' sustainability performance is the sustainability performance-based evaluation model, or SPbEM. The subject of PPP has seen a deluge of academic writing in the last few years. Better understanding of the knowledge structure and patterns in development may be achieved by a thorough and methodical literature research. study on PPPs (Song et al. 2019). So, for instance, Ke et al. (2009) used a two-stage literature review method to examine PPP papers published in four international construction journals between 1998 and 2008. They looked at the number of papers published each year, the authors' contributions, and the study topics covered. In a comprehensive research spanning 1990–2013, Osei-Kyei and Chan (2015) combed through a number of prestigious international publications to identify CSFs for PPP implementation. Either the number of research publications on PPP was little or the two studies narrowed down on a specific area within the PPP field. That is why the findings are not indicative of a global trend in PPP research. Using a three-stage literature review process, Zhang et al. (2016) culled 685 PPP articles published between 2005 and 2014 and subjected them to content analysis and statistical analysis to determine the primary research methodologies, study subjects, and results. A large number of PPP studies have been published since this study was done five years ago. From a life-cycle viewpoint, Bao et al. (2018) used a structured search strategy and a five-step categorisation procedure to identify and categorise 282 PPP international articles. Having said that, the conclusions of the literature evaluation were based on a very small sample size and do not represent the worldwide trend in PPP research. Recently, a comprehensive literature study and analysis was carried out by Jayasena et al. (2020) about the development of PPP models for the supply of smart infrastructure. The findings made it possible to classify the challenges and opportunities associated with building smart infrastructure under the PPP model. The results, however, were limited to one area of smart infrastructure research. A win-win situation in PPP was conceptualised by Eshun et al. (2020) after a thorough literature assessment. A total of forty constructs were categorised into six groups by the investigation. This study followed a similar pattern of narrowly focused investigation within the PPP domain of expertise. On the other hand, Zhang et al. (2020) combed through 12 prestigious construction

journals to find PPP articles published between 2009 and 2019. The PPP research that was developed and published in these publications was divided into seven categories. We mapped out the current state of the field, identified any gaps, and suggested five avenues for further study. This study's main flaw is that it relies on a single database and analyses only 279 PPP publications.
To get a broad grasp of a subject, bibliometric analyses use the descriptive method and specialised software (like CiteSpace) for knowledge mapping (Huang et al. 2019). This method has been used by several scholars from China and other countries to evaluate literature on the PPP topic. To illustrate PPP research trends in China, Huang et al. (2018) examined 400 articles with a high citation record from the China National Knowledge Infrastructure (CNKI) between 1997 and 2017. Song et al. (2019) used CiteSpace to perform a cluster analysis on 1,360 PPP papers published in the Web of Science (WoS) from 1996-2016, to depict the knowledge structure and emerging trends of PPP research. However, none of the aforementioned studies compared Chinese and foreign PPP research; instead, they only used PPP publications published in China or elsewhere as their study sample. Since globalisation has been the most noticeable and consequential trend in recent economic growth, global production networking greatly affects the completion of public-private partnership projects (Siemiatycki 2013). The need for comparative study is underscored by our inadequate knowledge of the variations in PPP development across regions, as stated by Chen et al. (2020). But most of the PPP studies that have been done so far have focused on one nation or one industry. Investigating this information gap is significant because PPP researchers may benefit from more thorough literature reviews that are the product of comparative studies including samples from two sources. This will allow them to do better research in the future. Following a methodology similar to that of Zhang et al. (2016), this study used CiteSpace to compare and contrast PPP research from China with those from across the world. In order to better grasp the parallels and contrasts between worldwide and Chinese PPP research accomplishments and trends, as well as how to proceed with future study in this area, academics from both China and outside will find this paper's research results useful. Further, PPP practitioners throughout the globe may be able to make better investment and management decisions if they have a general idea of how PPP is evolving in various economies.

3 Research Method

3.1 Research tool

CiteSpace is an information visualization software developed by Professor Chen from the Drexel University in the United States, which is very strong in conducting literature bibliometric analysis using the data mining algorithms and visualization methods (Chen 2004). Because it can present the structure, regularity and distribution of scientific knowledge through visual means (Li and Chen 2016), the software is often used to analyze the research hotspots, research frontiers and research trends in a specific area, such as Song et al. (2019). CiteSpace V software, with the version of v.5.5 R2 (64-bit), is utilized in this study to analyze the research trends in PPP field and produce visualized results such as node size, network connectivity and co-occurrence of keywords.

3.2 Data selection

CNKI is a popular database with the largest amount of digital publications in China. Hence, the Chinese PPP literature was collected from CNKI. WoS has excellent compatibility with CiteSpace (Li et al. 2018), and is one of the largest academic publication databases in the world (Jia et al. 2019), which has been widely used as the literature searching source in existing literature review studies (Hosseini et al. 2018). Hence, the selection of international PPP literature in English was derived from WoS. In order to improve the quality of literature samples, the Chinese PPP literature was generated from Science Citation Index (SCI) source journals, Engineering Index (EI) source journals, high-quality journals acknowledged by Peking University Library, Chinese Social Sciences Citation Index (CSSCI) source journals, and Chinese Science Citation Database (CSCD) source journals. The English PPP literature was collected from the WoS core collection. Since PPP includes a variety of models, such as Build-Operate-Transfer (BOT), Build-Own-Operate-Transfer (BOOT), Build-Own-Operate (BOO), Design-Build-Finance-Operate (DBFO), Transfer-Operation-Transfer (TOT) (Ke et al. 2011), all these

keywords were used to ensure a complete retrieval of PPP-related journal publications. The specific details used in the search process are shown in Table 1.

A three step data collection approach, similar to Zhang et al. (2016), was employed in this study. In the first step, using the search details shown in Table 1, a total of 3,121 and 512 records were generated from the CNKI and WoS core collection database, respectively. In the second step, a further manual screen was implemented to assure the journal papers being relevant with PPP topic through a review of the title and abstract of each paper, which led to 1,957 and 442 valid samples of Chinese and international PPP papers. Since PPP includes many other meanings in different fields, this step is very important to remove irrelevant publications to improve the quality of data analysis results. For example, about 40% of the publications was discarded in this step. In the third step, bibliometric analysis, with the assistance of CiteSpace software, was conducted to these valid PPP articles to achieve the proposed research objectives (Song et al. 2019), including keyword cluster analysis, keyword citation burst analysis, core research institution analysis and core author analysis.

4 Data analysis

4.1 Yearly number of PPP publications

The statistical analysis results of the publication time of the Chinese and international PPP papers are shown

It can be seen from Figure 1 that the number of Chinese PPP papers fluctuated slightly from 2008 to 2013, as is also the case for international PPP papers from 2008-2018. In 2013, at the Third Plenary Session of 18th Central Committee of the Communist Party of China, the Chinese government stated that social capital was encouraged to participate in the investment and operation of urban infrastructure through concession and other means. With this promotion from the central government, PPP has received strong national and local policy support in China (Zhang et al. 2016). This might explain the increasing trend of PPP research papers in China since 2014, with an average annual growth of 55.92% to 2018. During this period, the Chinese journals produced around 5 times of publications in total (1,952) with comparison to international journals (442). Based on the above analysis results, it is argued that the PPP topic is more popular to Chinese researchers than international academics, specifically from 2014-2018. In addition, a considerable amount of PPP journal papers in this period was authored or co-anchored by the researchers in China. Further analysis showed that on average the PPP journal publications in Chinese and international journals has been increasing with 33.09% from 2008-2018. Considering the development trend in the latest years, it is likely that PPP will still attract considerable attention from academia in the forthcoming years globally.

4.2 PPP research keywords

4.2.1 Keyword cluster analysis results

Using the CiteSpace software, node type was chosen as the keyword and the threshold was set as 20 to generate a knowledge map illustrating the cluster of keywords. The time series diagram of keywords is generated (see Figure 2 and Figure 3), showing the visualization of keyword clusters, change and connection of keywords overtime in Chinese and international PPP publications, respectively.

(Note: Research keywords appears sequentially with the time axis. The larger node stands for the higher frequency of research keywords and better centrality.

The line between the two nodes indicates that the keywords appeared in the publications simultaneously.)

From Figure 2, it can be seen that 7 clusters of keyword in Chinese papers were produced, i.e. PPP

4.2.2 Keyword clusters in Chinese PPP papers

Cluster 0 is the ***PPP model***, which can be merged with cluster 3 the ***public-private cooperation***, and cluster

4 the ***government and social capital cooperation***, which have the same meaning in Chinese. The construction of Shenzhen Shajiao B Power Plant in BOT model in 1985 was considered as the first project in China's PPP history. Due to the inherent nature of cooperation, benefit sharing and risk sharing, PPP is widely used in developing China's public services and infrastructure from then on. The interpretation or application model of PPP are different in different countries or at different historical periods. In China, the government emphasized the long-term cooperation between the government and social capital, and intended to improve the supply efficiency of public goods and service through utilizing the strong financing and operating capabilities of private entities (Zheng et al. 2016). MoF (2014) also claimed that the application of PPP model has improved the project performance and extended the public service scope. A variety of PPP models were applied in China. For example, the BT model was employed in Beijing Olympic subway project and Shenzhen No.5 subway project, whereas the BOT model was used in Shenzhen No.4 subway project. Considerable PPP research was focused on summarizing the lessons learned from the application of PPP model in these projects (e.g. Yang et al. 2014) .

Cluster 1 is the ***project financing***. Attracting sufficient capital investment from private entity is one of the most important features of PPP model. The large capital investment, long concession period and many uncertain factors make PPP projects frequently meet financial bottlenecks. Therefore, in this cluster the Chinese researchers mainly studied the application of financing models, financing risks and financing feasibility. For example, Yuan et al. (2011) established a financing structure optimization model based on Monte Carlo technology, and analyzed the main influencing factors and their functioning mechanism. Xiang and Song (2016) identified financial risk factors from the perspective of financiers, and analyzed the correlation between the various financial risk factors. Additionally, they constructed a causality diagram and a flowchart model of the dynamics of financial risk system. Wang et al. (2018) analyzed and verified the positive impact of financing intensity on the financial risk of PPP projects based on complex system theory and institutional theory. In addition, Hou et al. (2017) argued that asset securitization provided a new path for financing PPP projects and will have a broad application future in PPP area, since it had the advantages of increasing asset liquidity and achieving the objective of risk isolation.

Cluster 2 is the ***capital***. Under this theme, the Chinese researchers primarily concentrated on the topics of stakeholder management in PPP from the perspectives of public interest, responsibility allocation between the government and private entity, stakeholders' participation, public responsibility, and role of public and social capital. For example, Liu et al. (2014) selected 18 typical PPP projects and analyzed the asset characteristics and capacity requirements of different types of PPP projects, and summarized the international experience of equity structure and debt-to-equity ratio selection, through investigating the capital structure (only the equity structure and debt-to-equity ratio were considered) of the case projects. The results provided a valuable reference for the arrangement of capital structure of PPP projects in China. Wang et al. (2019) analyzed the allocation of project control rights between the government and social capital using the connotation of control rights

and decision-making theory, and identified the influencing factors of the control rights allocation for PPP projects. The research results showed that the degree of publicity of products and services, level of risk management of project company, and the degree of innovation of project technology were the main factors affecting the allocation of control rights in PPP projects.

Cluster 5 is the ***finance***. Compared with the pure public supply mode, the financial risks in PPP model are much higher. The information asymmetry caused by multi-party cooperation, contradiction between profitability-driven nature of social capital and equity of government's endorsement for public services, and opposition between public and private entities in risk sharing might bring potential financial risks to the government. Wen et al. (2015) established a scientific and comprehensive supervision technology and method for PPP project financial risk as well as risk supervision operation process and management system on the basis of lessons learned from international experience, and proposed recommendations on developing policy to strengthen the supervision finance risks in China's PPP projects.

Cluster 6 is the ***accounting***. Accounting had a direct influence on determining whether the accounting information of a PPP project met the quality requirements. Qualified accounting information can represent the property value flow of a PPP project and between investment entities, guarantee the safety and integrity of assets invested by the parties and the property rights of the PPP projects, and ensure the realization of public interest (Dong 2014). In addition, the decomposition and reconfiguration of property rights in PPP projects will further complement and improve the accounting theory and methods.

4.2.3 Keyword clusters in international PPP papers

Cluster 0 is the ***organizational capability***. PPP projects are usually initiated through solicited or unsolicited proposals. Different processes of proposing models often lead to different levels of government and social capital participation and responsibility. Therefore, organizational capacity is particularly important for both government and social capital (Yun et al. 2015). For example, Jin (2010) identified the main characteristics of transactions related to risk allocation in PPP projects from the resource perspective of organizational capabilities. Huang et al. (2013) concluded that well-organized public entity, appropriate risk allocation and sharing, as well as strong private entity are the most important CSFs for the implementation of PPP projects in Singapore.

Cluster 1 is the ***China***. China represents the trend of PPP development in developing countries because of its economic prosperity and huge construction investments in recent years (Cheng et al. 2020). Further analysis indicated that many international PPP research was focused on the study based on Chinese PPP project cases or from a Chinese perspective. For example, Chan et al. (2010a) studied the potential of applying PPP model in China, and conducted a questionnaire survey among Chinese construction professionals, to explore the critical success factors of initiating PPP project in China. Wang and Zhang (2018) used Bayesian analysis method together with expert judgment and historical data, to construct a risk occurrence probability model, which was used to predict the incidence of several key risks of PPP waste incineration projects in China.

Cluster 2 is the ***fuzzy synthetic evaluation***. It is a comprehensive evaluation method based on fuzzy mathematics, which is often used for quantitative analysis in PPP projects. For example, Xu et al. (2010) developed a fuzzy synthetic evaluation model to determine the fairness of risk allocation between the government and private entities. Wu et al. (2017) identified 44 risk factors and calculated

the probability of occurrence, influence magnetite, comprehensive risk level and total risk using fuzzy synthetic evaluation, to evaluate the risks of straw power PPP project in China.

Cluster 3 is the ***public-private partnerships***. As a modern mode of financing and operating infrastructure project, the PPP concept is accepted and applied by more and more countries in the world, and is considered as originating from the Private Finance Initiative (PFI) mode in the UK. Because the PPP model has been applied in western countries much earlier than in China, the lessons learned from these successful and failed projects provide valuable guidance in the PPP application in China. According to Grimsey and Lewis (2005), achieving improved Value for Money (VfM) or enhanced quality of services with the same investment was of paramount importance to the public sector, which might explain why PPP was a popular model in initiating a project. Almarri and Boussabaine (2017) also argued that VfM was a critical factor for the public sector to choose the PPP model in a specific project, instead of traditional procurement methods. In fact, the experience and expertise of the private entity were utilized to achieve VfM, in terms of higher-level of innovation, efficiency and quality (Osei-Kyei and Chan 2015).

Cluster 4 is the ***BOT contract***. As mentioned earlier, BOT is one of the important models of PPP, and BOT contracts are often used in developing infrastructure projects. In this field, Ashuri et al. (2012) employed real options theory to determine the price minimum revenue guarantee option in BOT projects. Feng et al. (2015) investigated the impact of government guarantee on toll, road quality, and road capacity in BOT highway projects from the perspective of the private sector. Song et al. (2017) established a bargaining game model with complete information to analyze the negotiation process of early termination compensation, and provided a compensation scheme for early termination in BOT highway projects to resolve the problem of incomplete contracts. In fact, in the early PPP research outcomes, Dr Robert Tiong in Singapore leading the research team has contributed lots of efforts on the risk management study of BOT projects in China (Ke et al. 2011).

Cluster 5 is the ***project management***. With comparison traditional projects, the management of a PPP project is much more challenging due to the increased complexity of contract system, a significant number of parties involved and a much longer period of construction and operation duration (Zhang et al. 2016). Several pieces of literature were focused on the research of project management issues in PPP model. For example, Kavishe and Chileshe (2018) employed the theory of innovation diffusion to determine the degree of integration of project management practices and principles during the PPP implementation stage of housing projects in Tanzania. Due to the specific nature of PPP model, a number of critical factors have impact on the successful management of these types of projects. For instance, Love et al. (2015) suggested that the adoption of Building Information Modeling (BIM) can enable key decision-makers to make informed decisions throughout the project life cycle, and hence BIM can be considered as the catalyst for future proofing PPP projects which can achieve the successful management of an asset across its life-cycle. Cluster 6 is the ***risk analysis***. Similar to the findings of Ke et al. (2009), risk analysis is one of the central research topics in the PPP field. Objective, reliable, and practical risk analysis was critical to the successful implementation of a PPP project (Xu et al. 2010). According to Song (et al. 2019), the risks associated with PPP projects were primarily explored by researchers from two aspects: risk identification and risk allocation. For example, Iyer and Sagheer (2010) identified 17 type of risks in the developmental phase of PPP project from the scenario of road sector in India. Chan et al. (2011) identified and evaluated the main risks of implementing PPP projects in China, and

proposed an appropriate risk allocation strategy between the government and social capital. Yuan et al. (2015, 2018) derived six potential dimensions of residual value risk (RVR) factors in the Chinese PPP projects, including poor maintainability, decrease in operation function and poor sustainability. Nguyen et al. (2018) investigated critical risks influencing the financial viability of the Vietnamese PPP toll road projects and categorized them into four primary types: construction cost risk, operation revenue risk, operational and maintenance cost risk, and financing cost
risk.

4.3 Keyword citation burst

The analysis results of keyword citation burst reveal the frequency of a specific keyword cited in the publications over a certain period of time, and are another valuable reference to understanding the development trend of the research theme (Li and Chen 2016). The analysis of keyword citation burst was conducted in the Chinese and international PPP papers, and the results are shown in Table 2 and Table 3, respectively.

As shown in Table 2, similar to the analysis results of keyword clusters, in the research period, the financing issue was always an attractive topic in China, since five related Chinese keyword bursts were generated in the analysis process. Specifically, internet finance was the latest research topic in Chinese PPP papers. Wu and Wang (2017) argued that the Private to Government (P2G) platform can use the internet technology to make the government service and product supply free of geographical and time constraints, and also provide a new way to relieve the local government of financing burden. If the topics of investment and VfM were also included in the financing research field, it is argued that the researchers in China paid more attention to the research of PPP economic issues during this period. In 2011, the Chinese government stated that social capital was encouraged to enter into the affordable housing construction (MOHUD 2011), which might explain the high citation level (8.6011) of this keyword in 2012-2014.

While in Table 3, the international researchers were more focused on the PPP project management related issues, such as the early procurement and risk management, optimization and project management, followed by contracting and concession model. As stated by Chan et al. (2010b), PPP procurement was considered an effective way to achieve VfM in providing public infrastructure or services. However, in order to achieve the success of a PPP project, the various stakeholders should pay special attention to these project management issues. Additionally, in recent years, research on the lessons learned in successful and failed PPP projects was very attractive in international PPP papers. For example, Wang and Ke (2018) summarized lessons learned in a vehicle charging infrastructure in Anqing, China, and proposed relevant suggestions for implementing similar projects in the future.

4.4 Core research institutions

Using CiteSpace software, the institution was chosen as the node type and the threshold was set to top 20, to generate a knowledge map showing the contribution of PPP by different institutions. The cluster analysis results of core institutions in Chinese and international PPP papers are shown in Figure 4 and Figure 5, respectively.

As shown in Figure 4, the core research institutions contributing most of the Chinese PPP papers in descending order are the Chinese Academy of Financial Sciences (*Zhongguo Caizheng Kexue Yanjiuyuan in Chinese*), the Institute of Financial Science of the Ministry of Finance (*Caizhengbu Caizheng Kexue Yanjiuyuan in Chinese*), Tianjin University of Technology (*Tianjing Ligong Daxue in Chinese*), Tianjin

University (*Tianjing Daxue in Chinese*), and Chongqing University (*Chongqing Daxue in Chinese*). The findings also indicated that the research collaboration between these institutions was not strong, although considerable Chinese PPP papers were published in the period.

It can be seen from Figure 5 that, the core research institutions contributing most of the English PPP papers in descending order are the Hong Kong Polytechnic University, the University of Maryland, the Hong Kong University of Science and Technology, Tsinghua University, and Southeast University. With comparison to the status in Chinese PPP publications, the research collaboration between these institutions was much stronger in producing international PPP research papers.

4.5 Core authors

Employing CiteSpace software, the author was chosen as the node type and the threshold was set to top 20, to produce a knowledge map showing the contribution of PPP research by different authors. The cluster analysis results of core authors in Chinese and international PPP papers are shown in Figure 6 and Figure 7, respectively.

As illustrated in Figure 6, the core authors publishing most of the Chinese PPP papers in descending order are Mr. Jia from the Chinese Academy of Financial Science, Professor Yuan from the Southeast University, Professor Ye from the Chongqing University and Professor Wang from the Tsinghua University. The figure also indicates that the collaboration of these researchers was strong in their institution and was weak with researchers from other institutions. While as shown in Figure 6, Professor Chan from the Hong Kong Polytechnic University and Professor Skibniewski from the University of Maryland contributed most of the PPP publications. These researchers had more strong research collaborations within and outside of their own institutions.

5 Conclusion

The government's strong encouragement of PPP as a model to improve project performance and alleviate the severe financial burden in both developed and developing nations has led to a flood of PPP papers published in Chinese and international journals in the last several years. Separate analyses of foreign journals and Chinese journals constituted the bulk of earlier literature reviews on PPP topics. An current knowledge gap in this sector is the lack of a bibliometric study comparing recent articles with a substantial number of PPP papers. It is important to investigate this because the results will help PPP researchers throughout the world better understand the historical study trend and to conduct future relevant studies.
A bibliometric study was carried out on PPP research published in Chinese and international journals from 2008-2018 using CiteSpace software. The study looked at factors such as the number of publications per year, clusters of keywords, bursts of keyword citations, core research institutions, and significant authors' contributions. Two rounds of rigors research led to the identification of 1,957 genuine PPP journal publications in Chinese journals and 442 valid PPP journal papers in foreign journals, respectively, for further analysis. Results showed a 33.09% increase in the overall number of PPP papers published in China and abroad on typical from 2008 to 2018. Based on the development tendency in the last 5 years, PPP is anticipated to be an appealing issue in the approaching years. Chinese PPP articles tended to investigate PPP-related funding difficulties more extensively, according to keyword cluster and citation burst analysis findings, while foreign journal publications tended to concentrate on PPP-related project management concerns. Furthermore, significant institutes and writers from both domestic and foreign PPP studies were located. Researchers writing PPP articles in China were also less likely to collaborate with institutions outside of their own than their overseas counterparts, according to the data. Therefore, it is recommended that Chinese scholars strengthen their research cooperation in the PPP sector. In addition, while there is a substantial amount of literature on public-private partnerships (PPPs), there is surprisingly little comparative research from a global perspective. This is especially true when looking at the best practices of PPP application across sectors like water,

transportation, wastewater treatment, and power, as well as across projects utilising various PPP models (e.g., BOT, BT, PFI, etc.). As an example, consider the work of Cheng et al. (2020), who examined the PPP model in China, India, and the UK from the perspectives of policy, development process, contract type, sector distribution, and investment volume. Given the high stakes nature of public-private partnership (PPP) initiatives, this study will provide light on the critical success factors (CSFs) of PPP in various contexts, which will benefit both academics and practitioners in the field. Moreover, policymakers will find the study results useful in creating more appropriate rules and regulations that control the PPP implementation process, which is crucial for the success of PPP projects. Finally, considering the rapid advancement of contemporary technology in the construction business, it would be fascinating to investigate its potential use in PPP projects to improve performance in the future. As an example, Yuan et al. (2019) shown via an experimental system that PPP projects may be made more efficient with the use of building information modelling (BIM) and other forms of information technology.

While acknowledging the study's shortcomings, it is important to consider them alongside potential avenues for future research in this area. First, for the purpose of maintaining a high standard in Chinese PPP literature, we exclusively included papers published in first-tier journals for our analysis. These journals include SCI, EI, journals acknowledged by Peking University library, CSSCI, and CSCD. The same holds true for the PPP articles that were selected for inclusion in the WoS core collection. It is possible that some high-quality PPP articles will be disregarded as samples in this situation. Second, it's possible to get partial results when you use keywords to analyse research trends; after all, the abstract, discussions, and conclusions of a paper are the best places to get the most relevant information. Finally, even when presented with a mountain of data, CiteSpace is able to reliably provide objective analytical findings. Supplementing these findings with subjective data analysis will make the study findings more thorough. Nevertheless, due to the study's restricted literature examination, several important research results from those studies were overlooked.

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