

# A systematic review of Public-private partnership in construction industry from 1998 to 2021

Chen Yin  
O. Mohamed  
Koh Mei Ye

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*Chen Yin, Department of Quantity Surveying*

*\*O. Mohamed, Faculty of Built Environment  
othmanmohamed@um.edu.my*

*Koh Mei Ye, Universiti Malaya, 50603, Kuala Lumpur, Malaysia*

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## Abstract

The public-private partnership (PPP) has become a global concept to deliver the public facilities and services. Considerable studies on PPP have been made by researchers since it adopted in 1980s. Diverse research achievement can be seen in all kinds of journals. This paper conducted a content analysis of 498 articles between 1998 and the March of 2021 aims to provide a holistic review for the development of PPP mainly in construction field. Six journals consist of five construction journals and sustainability (Switzerland) were selected to analysis in detail pertain to the publication yearly, distribution of country or region, mainly project sectors involved, research methods used, and main research domains. The findings show that PPP research has been increasing yearly, and is developing rapidly. China surpassed the UK, HK, USA, became the country with the largest number of publications on PPP. In addition, 12 research topics were identified, along with the knowledge gaps and direction need to address in the future research.

**Key words:** Public-private-partnerships (PPP); Infrastructure; Construction industry; Review

## Introduction

Public-private partnership (PPP) has been taking as a mechanism by developed and developing countries to deal with the delivery of public infrastructure projects and service more than 30 years [1, 2] It is generally acknowledged that the Private Finance Initiative (PFI) as the most popular models of PPP which originated in United Kingdom (UK) [3] [4]. It provides an effective approach for the UK government to the contradiction between the severe public capital constraints and the huge demand of infrastructure investments [5]. Beyond that, there are many other drivers for countries around the globe to adopt this route. For instance, PPP can deliver better public facilities and service than the traditional contracting [6]. And to reach the goal of value for money through high quality, lower project cost and shorter construction time [7].

Currently, the PPP is widely used in various sectors of economic and social infrastructure [8] the main sectors including: transportation (road, highway, airports, seaports), education like schools, healthcare, water supply, energy, power, accommodation, and defense [6]. There are a lot of successful cases, such as, Hong Kong Disneyland Theme Park and A power sector PPP project named Laibin B power station in 1997 in Guangxi China got spectacular success [9, 10]. Moreover, till the end of the July in 2018, a total of 7,867 PPP projects were registered in China's national database The Ministry of Finance, 2018. In UK, the government approved 700 PFI projects since the PFI launched in 1992 to 2008 [11]. In Victoria State of Australia, also, 24 PPP projects have been signed up, the investment amount up to \$12.4 billion.

However, the mode of PPP is not a panacea suits all kinds of projects, and not every country can make good use it [4], the development level of PPP in different countries is not synchronized and consistent [12]. There are all sorts of barriers during the process of implementing the PPP. Lacking the appropriate knowledge and skills is a very important factor leads to project failure [13]. The very fact that PPP is fraught with controversy, which also means that there is still a lot of room for innovation and improvement in this area [14].

In the last decades, a large number of research scholars have made great effort in this area. A wide range of studies on different research themes, fields, project sectors and methods have been published in all kinds of Journals. [15] analyzed 34 articles on PFI in four selected construction industries journals from 1998 to 2003, the results show that most of research were about the risk and financial issues associated with PPP/PFI. On this basis, [10] filtered 107 articles in the six leading construction management journals from 1998 to 2007, the authors made a detailed analysis from two aspects: empirical research and non-empirical research. Around the same time, [4] probed into 170 articles in the seven journals that published the most papers on PPP in the construction field from 1998 to 2008. The research topics were expanded to seven categories compared with [15]. [16] examined more than 600 papers from Web of Science published between 1990 and 2014, the results of analysis indicate that almost 80% publication focused on the limited topics, which are contract performance, costs and benefits, contract design and risk sharing, political and institutional issues, and value for money. The research gap like contract renegotiation and termination waiting to explore for scholars.

In order to make PPP in developing and developed countries to achieve greater success and get sustainable development, continuous assessments and exploration on PPP are necessary. This study, therefore, aims to investigate the current research status, research trends and future topics for PPP infrastructure projects through a systematic literature review from 1998 to March of 2021. Since a critical review of the existing literature can help us gain a comprehensive understanding of PPP.

In the later section, a brief overview of PPP including the definition of PPP, the model and weakness of PPP is first given. Then the method of the research is established. Followed by a detailed analysis on the findings of a systematic literature review. Finally, a brief conclusion is identified, also the research limitation and future research directions.

## **The overview of PPP**

### ***Concept of PPP***

Though PPP has become a global concept [9]. Yet, to date, there is no universal definition of PPP, large difference exists in various countries [17]. The United Kingdom's HM Treasury define PPP as "a long-term contractual arrangements between a public

sector entity and a private sector provider. The private sector provider is engaged to design, build, finance, maintain and operate infrastructure assets and related services. The risks associated with construction delay, cost overrun and maintenance of the asset are transferred to the private sector partner". While in Canada, PPP is "a cooperative venture between the public and private sectors, built on the expertise of each partner that best meets clearly defined public needs through the appropriate allocation of risks resources and rewards" (Canadian Council for Public- Private Partnership 2010).

World Bank Guideline(WBG) define PPP as "A long-term contract between a private agent (or private economic operator) and a public agent (also referred as government authority or public authority), for the development and/or management of a public asset or service, in which the private agent bears significant risk and management responsibility thorough the life of the contract, and remuneration is significantly linked to performance, maintenance and/or the demand or use of the asset or service."

Although the definition of PPP is slightly different in various countries, the key features are the same. Firstly, it is, for instance, a multi-partner collaboration which involves more than two stakeholders [18]; Secondly, it is a long-time contractual partnership often up to 25 or 30 years; Thirdly, PPP concentrate on exploiting the complementary resource and sharing the risks and responsibility [19]. Therefore, it is not easy to implement a PPP project because the nature of complexity.

### **Forms of PPP**

According to the degree of private sector involvement, as shown in figure1, there are total of eight forms of PPP including wider market, asset sales, sales of business, private finance initiative, partnership companies, joint ventures (JV), partnership investments, and policy partnerships which are recognized by the UK government [20].

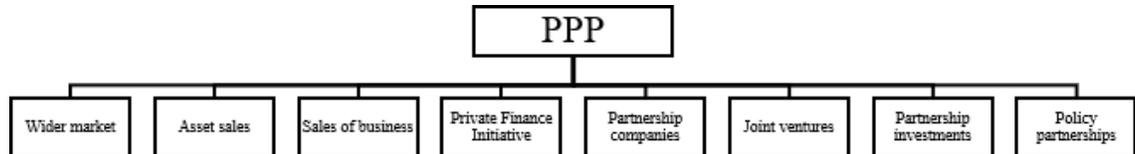


Figure1. Types of PPP [20]

Besides, The Canada Council for Public-Private Partnerships proposed a simplified spectrum of PPP models which is classified based on the extent of participation and degree of risk allocation between the public and private sector. The more common procurement include: Operation & Maintenance Contract(O&M); Build-Finance; Design-Build-Finance-Maintain(DBFM); Design-Build-Finance-Maintain-Operate (DBFMO); Concession.

### **Weaknesses of PPPs**

The experience of past PPP practice and many empirical studies show that the overall performance of this model is not satisfactory [8, 21]. Some prominent problems as follows:

- The procurement process always long and expensive;
- The PPP contracts lack of sufficient flexibilities;
- Insufficient transparency on the future debt to end-user and returns to investors;
- Inappropriate risk allocation and lacking of risk transfer standards between public and private sector;

- Unsuitable model used to PPP projects leads to the failure of value for money; and
- Inaccurate estimation of services demand.

### Research Methodology

This review aims at continuing to investigate the evolution of PPP in the construction field on the basis of previous studies like [4, 10, 15]. Therefore, the method of a content analysis of papers on PPP from 1998 to March of 2021 is adopted. The systematic literature review is divided into four stages (shows in figure 2):

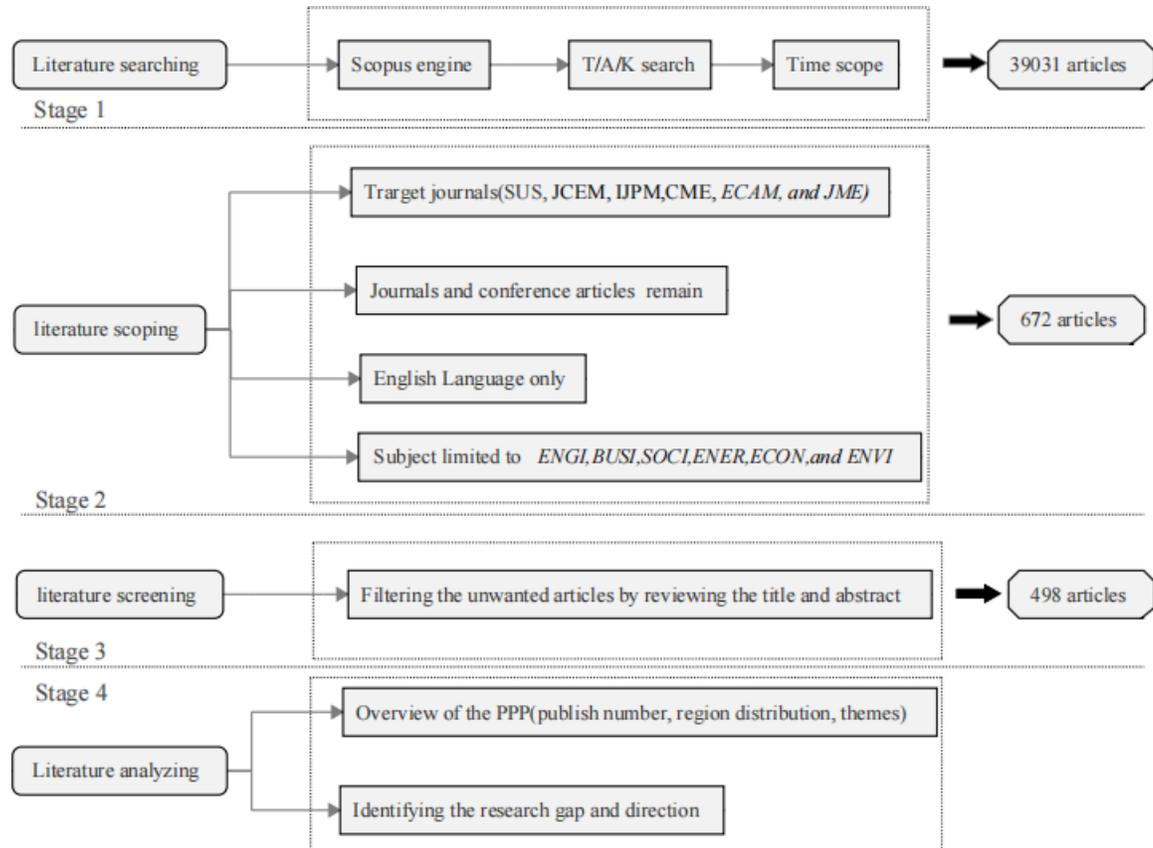


Figure 2. Framework of the systematic literature review

**In stage 1:** A simple search is conducted. The main database of the search engine is Scopus. Compared with other databases, for instance, Web of Science and google scholars. Scopus have more coverage of journals. In addition, Scopus provides the highest level of reliability as it is the largest scientific database of abstracts and citations of peer-reviewed literature. At the same time, the operation is simple and convenient. Then based on the research objectives determined the key words. The key words used in this article were: “Public–Private Partnership”, “Private Finance Initiative”, “Build–Operate–Transfer”, “Build–Operate–Own”, and “joint ventures”. The final search result was 39031 articles with these key words, titles, or abstracts.

**In stage 2:** Screening the articles that are not related to the topic. Since the above search also including a lot of papers from medical or chemistry which were not fit for this review. The subject further limited to: “Engineering”, “Business Management and

Accounting”, “Social Science”, “Energy”, “Economics, Economics and Finance”, “Environmental Science”. And only English articles and conference papers were chosen. Additionally, for the types of publication, this study mainly focuses on the Journal. Following is the complete search code:

*(TITLE-ABS-KEY(public-private AND partnership) OR TITLE-ABS-KEY(private AND finance AND initiative) OR TITLE-ABS-KEY(build-operate-transfer) OR TITLE-ABS-KEY(build-operate-own) OR TITLE-ABS-KEY(joint ventures))AND PUBYEAR > 1997 AND (LIMIT-TO(DOCTYPE, “AR”) OR LIMIT-TO(DOCTYPE, “CP”)) AND LIMIT-TO(SUBJAREA, “ENGI” OR LIMIT-TO(SUBJAREA, “BUSI” OR LIMIT-TO(SUBJAREA, “SOCI” OR LIMIT-TO(SUBJAREA, “ENER” OR LIMIT-TO(SUBJAREA, “ECON” OR LIMIT-TO(SUBJAREA, “ENVI”)) AND (LIMIT-TO(LANGUAGE, “English”)) AND (LIMIT-TO(SRCTYPE, “j”))*

The search results found that Sustainability Switzerland (SUS) published the most papers on PPP total 218 articles. SO, this journal was selected the target journal in next stage. Owing to this review is to investigate the evolution of PPP in the construction field, five leading journals in construction management employed, *Construction Management and Economics (CME)*, *the ASCE Journal of Construction Engineering and Management (JCEM)*, *Engineering Construction and Architectural Management (ECAM)*, *Journal of Management in Engineering (JME)*, *International Journal of Project Management (IJPM)*. According to the ranking of (Wing, 1997), these five journals are in the top ranking of construction industry. Research papers published in these journals are relatively high quality with rigorous research method and convincing results. It is proved that JCEM, IJPM, and CME are the three journals that published the most articles after SUS.

**In stage 3:** Excluded the unwanted papers manually. After the last stage, 672 articles were left. However, there are still some unwanted publications that hard to exclude. It deserves serious checked the title and abstract in detail manually. In the end, 498 articles as shown in table1 were remained to be analyze in the next stage. It is found that, after filtering, 117 publications related on the PPP infrastructure has been published on JCEM and ranked top; next was IJPM with 99 articles, followed by SUS(=89), JME(=73), CME(=71), and ECAM(=49).

Table 1

The final number of papers selected for further analysis.

Journal Name		Number of papers
JCEM	Journal of Construction Engineering and Management	117
IJPM	International Journal of Project Management	99
SUS	Sustainability (Switzerland)	89
JME	Journal of Management in Engineering	73
CME	Construction Management and Economics	71
ECAM	Engineering, Construction and Architectural Management	49
Total		498

**In stage 4:** A comprehensive analysis carried out to further investigate the trend of the PPP. First to get an overview on the PPP regarding the amount of publication annually, the national and regional distribution of the publication, the project sector involved, and

main research methodology used by researchers. Afterwards, identifying the main categories of current research on PPP. And based upon this, proposing the research gap and potential direction.

**Results and discussion**

***Number of papers yearly***

Figure 3 shows a growing number of publications on PPP in six selected journals from 1998 to the end of March 2021. Total 498 articles have been published over the last 23 years. The data states that the growing attention on this field has been paid by the scholars, especially in the last several years. In general, three stages can be divided into for the development of academic research on PPP: (1) from 1998 to 2004, which is the initial stage, in this stage, the number of published papers has developed slowly. The reason would possibly be that PPP was still being explored both in academic and practical, the experience and data were scant; (2) from 2005 to 2016, which is the substantial promote stage. At this stage, the number of articles published doubled compared to the previous period with the concept of PPP spread from UK to more developed and developing countries; (3) from 2017 to present, rapid development stage, since 2017, the number of papers has increased explosively, and this trend is likely to continue. This result proved that the academic research and industrial practice are mutually reinforcing [1].

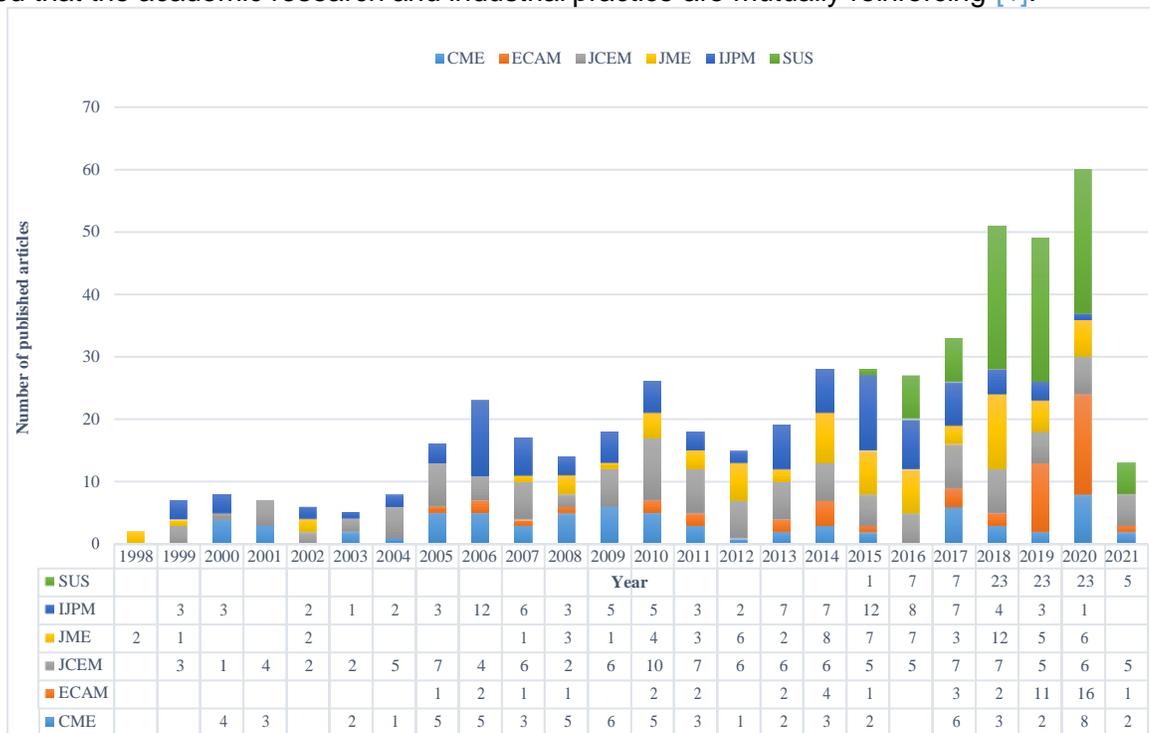


Figure.3. Number of publications yearly in the selected journals from 1998 to 2021

***Number of publications distributed by country***

With PPP being widely applied around the world, various countries have carried out different degrees of research on PPP. The scholars of reviewed 498 articles came from 54 different countries or regions. Only the first author is considered for all articles. Besides,

in this review, only the top 20 countries or regions were selected for analysis. We see that mainland of China contributed 123 articles in selected six journals from 1998 to March of 2021, different from the findings of [1, 4, 10]; and [19], most of the PPP articles originated from mainland of China, instead of UK who was first adopted the model of PPP. Just as show in Figure 4, China has entered a stage of rapid development since 2015, when China began to overtake the UK. In 2017, China became the country with the largest number of published papers surpassed the HK, UK, and USA. One of the reasons for this is, since 2013, the Chinese government has vigorously promoted the model of PPP, which was stimulated a broad application in various sectors in China [22]. In addition, the number of transnational PPP projects invested by Chinese firms in One Belt And One Road countries has also increased significantly, after Belt and Road Initiative (BRI) proposed by Chinese President in September 2013 [1, 23]. The practice of PPP model has greatly strengthened the research of scholars on PPP.

The findings also reveal that most of the academic output focused on developed countries, this implies that there is a big difference and not consistent in the level of PPP development between developed and developing countries [1], which to a large extent, due to the variation of the investment climate. An appropriate environment plays an active role in implementation of PPP [24]. Compared with developed countries, developing countries incline to political unstable, regime vulnerable, rules and policies unsustainability, government transparency, technical inadequate, and underfunded, these are the challenges and obstacles faced by developing countries [25]. Nevertheless, PPP has a greater prospect in developing countries than developed countries, since there is a mass need both for economic and social infrastructure in low and middle-income countries [26, 27].

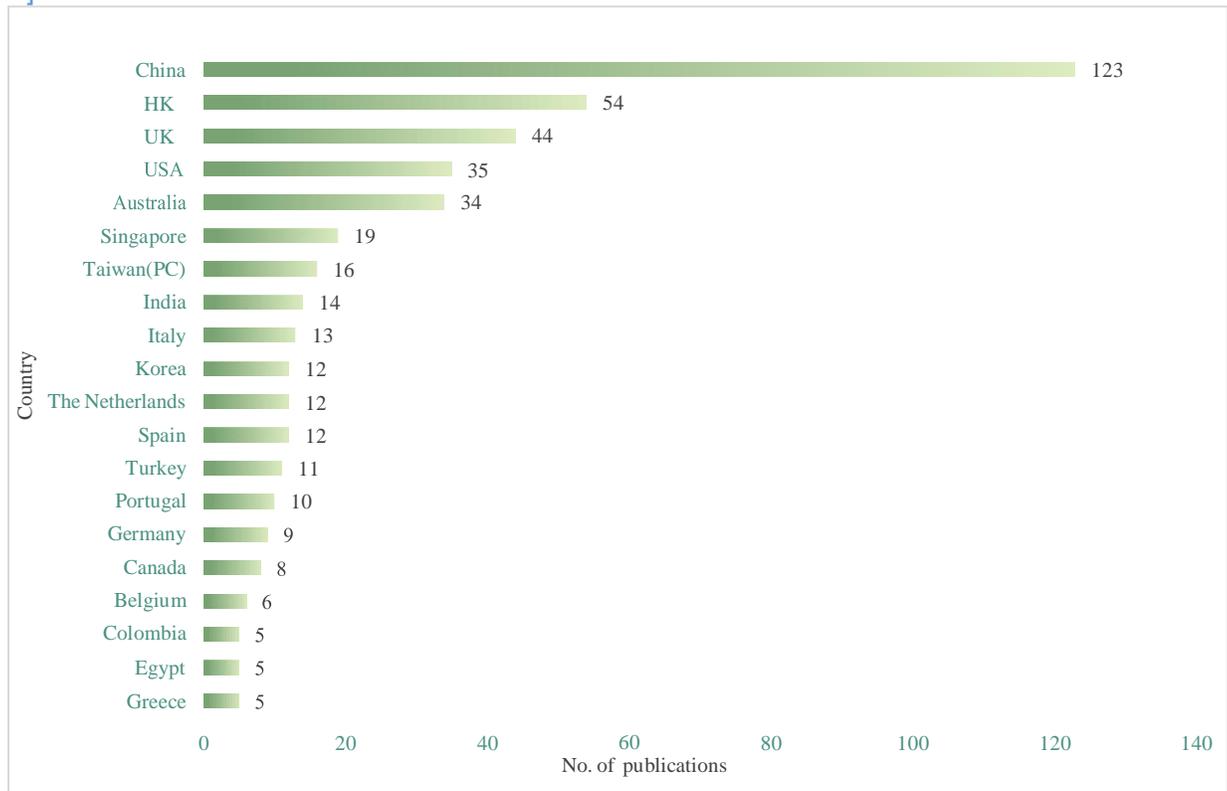


Figure 4. The distribution of the top 20 countries or regions for the number of papers

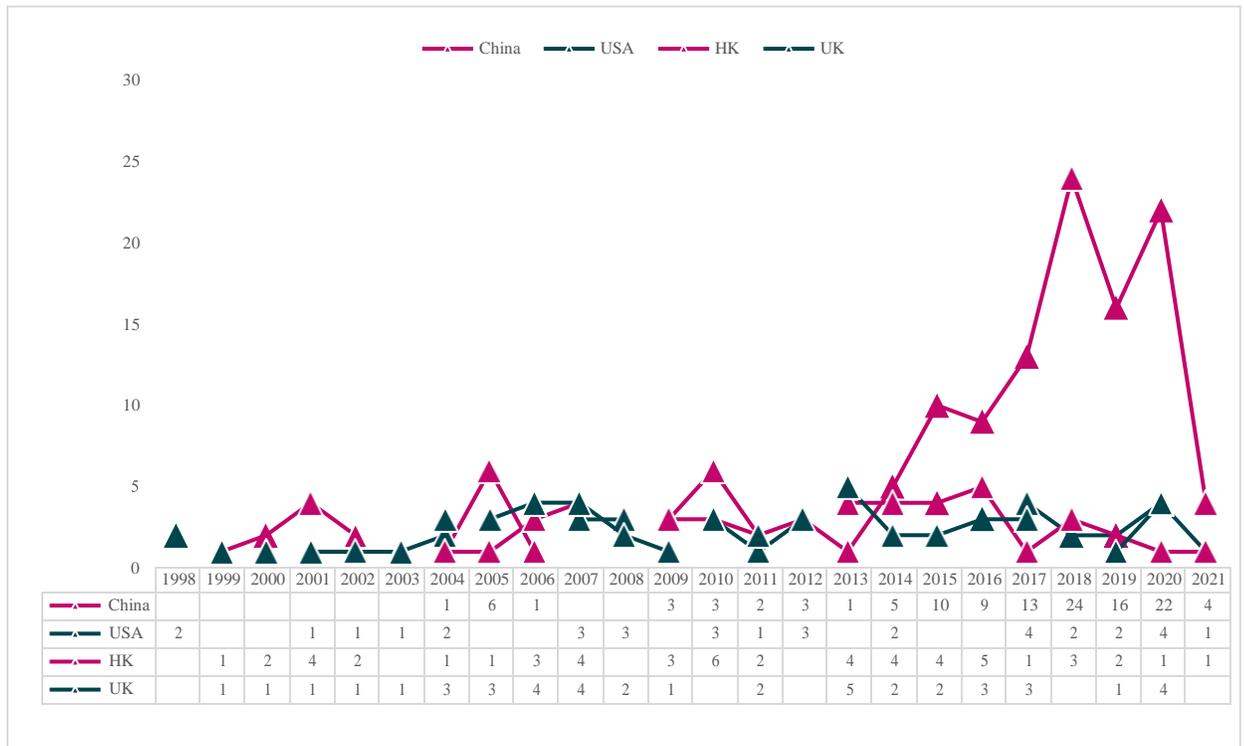


Figure 5. Comparison of the number of articles in China, UK, US, and HK

**Publications distributed by project sectors**

Table 2 shows the distribution of specific sectors in articles in selected six journals. It can be found that the model of PPP was widely used in various project sectors, main project sectors namely: transportation, housing, energy, health care, irrigation, waste, education, water, and urban related. Among these infrastructure programs, the broadest studied was the transportation, which is coincide with the findings of [1] and [28]. The second most studied area identified in this research is water sector, including wastewater treatment and water supplying. Then followed by energy, housing which ranked third and fourth respectively. Obviously, the research on PPP model mainly concentrated on economic infrastructure projects, which started earlier than social infrastructure in PPP application. It largely because economic infrastructure got greater policy support from government since these facilities could increase productivity and facilitate a country’s economic growth [29].

With the development of economy, social infrastructure projects have begun to involve in PPP to meet people’s increasing demand for healthcare, education, and sports. For instance, smart hospitals, tourism PPP, and sports and leisure projects emerged in literature. Moreover, in recent years, the combination of PPP and sustainable development has also started to be explore. For example, [30] proposed an assessment framework based on the dimension of sustainability to solve effectively the problem of clean coal district heating. It can be inferred the issue of sustainability would be a hot topic in the PPP field in the future.

Table 2

Number of project sectors were analyzed in publications.

Sectors	Subsectors	Numbers	Amount	Rank
Transportation	Transport	12	55	1
	Airport	1		
	Sea port	1		
	Channel Tunnel Rail Link	2		
	Expand Subways	1		
	Freeway	17		
	High Speed Rail	2		
	Road PPP	16		
	Road maintenance projects	1		
	Pipeline projects	1		
	Urban Light Rail Systems	1		
Housing	House building	7	12	4
	Low-cost housing	1		
	Rental housing (PRH) projects	2		
	Rental retirement village projects	1		
	Residential Renovation Projects	1		
Energy	Energy	3	13	3
	Electric Vehicle Charging	1		
	Nuclear power plant megaproject	1		
	Power Plant	5		
	Natural Resource	1		
	Forest Protection	1		
	Clean Coal	1		
Health care	Health-care	5	9	5
	Hospital PPP	1		
	Smart Hospitals	1		
	Sports and Leisure	2		
Irrigation	Irrigation projects	1	1	9
Waste	Municipal Solid Waste Disposal	1	5	7
	Nuclear waste disposal project	1		
	waste	1		
	Waste-to-Energy	2		
Education	School	2	2	8
Water	Water sector	5	21	2
	Sewer projects	1		
	Wastewater treatment plant	5		
	Water supply	9		
	urban water environment treatment	1		
Urban	Urban regeneration	1	6	6
	Urban infrastructure	3		
	Prison	1		
	Tourism PPP	1		
Total		124	124	

### **Research methods most used in PPP research**

The research methods used in the 498 articles were summarized by content analysis method, as shown in figure 6, in construction management area, a variety of methods were employed to study the PPP topics. Case study account for 28% was the most adopted by researchers, followed by modeling and framework, which account for 27%.

Then questionnaire survey and interview were 18%, and 11% respectively.

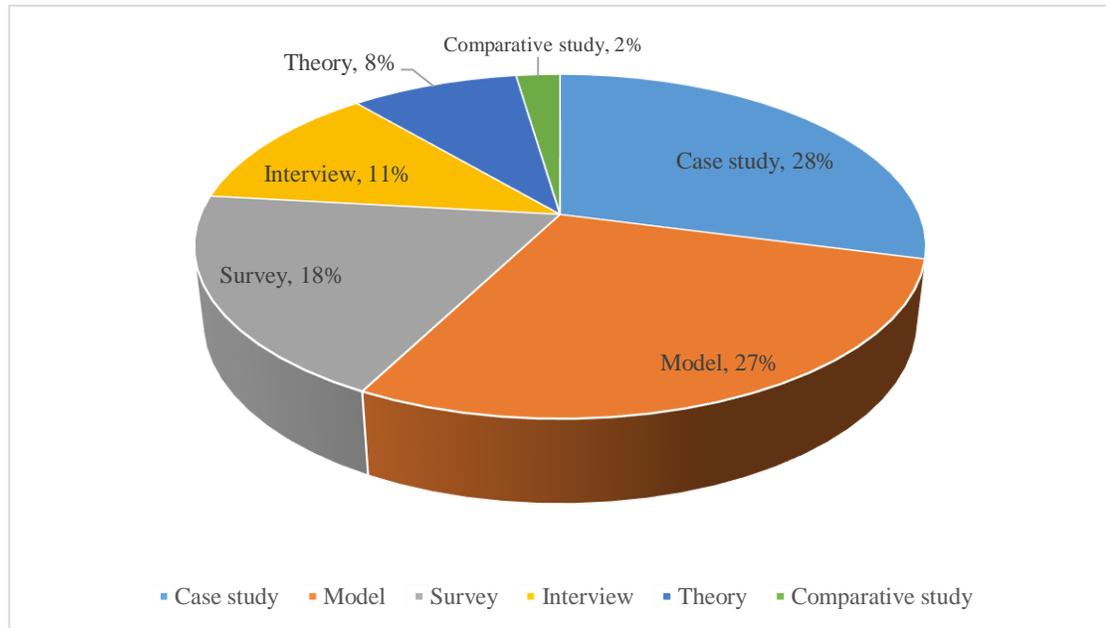


Figure 6. Research method used in the selected publications.

### **Case study**

It is found that the purpose of the case study is twofold through the comprehensive analysis on the literature. First is to clear the unique features and structure of the specific PPP project under certain environment or identify all kinds of factors and risks affect the performance of PPP. Due to the complexity nature of the PPP, which is always involved multiple stakeholders, large investment, and long concession. Each project has its own special organization structure, financial mechanism, and concession period. In addition, different legal system, political and economic background resulted in various project characteristics [4]. As such, case study is quite appropriate to deeper understand the situation of PPP implementation, then to accumulate the knowledge and experience for researchers and practitioners. [13] investigated three cases in UAE and identified the critical success factors and failure factors for PPP for example. Similarly, Babatunde, [31] spotted 58 barriers to apply PPP in Nigeria.

The second purpose of case study is to validate the model, framework, or a solution [19] used a case study to illustrate the Black-Scholes-Merton (BSM) model. [32] tested a decomposed evaluation model by a case to access the important decision factors influence the feasibility of BOT projects. [21] conducted a Chinese PPP project to examine a conceptual framework of the government accountability.

### **Modeling**

The method of modeling refers to base on a specific theory or mathematical approach to set up a model to project managers or public workers to make the right option.

The model can be used in almost all PPP related theme research. In the initial stage, developing a model to determine a better route under certain condition [12]. Then describing the interaction among the project cost, performance, and strategies by proposing a novel stochastic model [33]. Maximizing the overall performance through a Stackelberg game theory–based model [34]). Balancing the interest between public and private via revising net present value (NPV) financial evaluation model [20] The risk management model could help to assess, predict the risk allocation strategies, and minimize the impact of risk to project [20, 35, 36].

### ***survey***

Questionnaire survey is widely approached method which collecting the needed data from the appropriate respondents by using a series of pre-designed questionnaires. Owing to its operation is simple and economical, it is welcomed by researchers, including those in the construction industry. In the selected papers, two kinds of survey were identified, first is regular questionnaire. [20] explored the preference of risk allocation by conducted a questionnaire survey. [13] established a conceptual KPIs framework according to the structured questionnaire survey results. [37] quantified the influence of risk cost on risk allocation based on questionnaire survey which included nine risk subcategories.

Another survey method named Delphi survey, compared with the general questionnaire survey, Delphi survey is more reliable and rigorous since it often conducted two or three rounds to improve the quality of the collected information. While, the results of content analysis show that at present the Delphi survey only focused on the risk management of PPP, especially on risk allocation.

### ***Interview***

The method of interview usually used in conjunction with case studies. Interview is often used to obtain effective information in case studies. For example, [38] conducted five semi-structured interviews consisted of two interviews with private managers, two with public clients and another with an independent agent of PFI projects. Final concluded that during the operation phase of the PFI projects, the performance deduction level is low. In order to establish a framework to enhance the external stakeholder management of PPP projects, [39] employed two case studies detailed to 23 interviews with a wide range of stakeholders. Interviews have also been used separately in the past PPP studies, such as, expert interviews were used to construct the critical success factors framework for PPP infrastructure projects [2]. [40] conducted 38 semi-structured interviews with project leaders to identify the drivers for PPP in sustainable natural resource management.

### ***theory***

Theory generally regarded as a theoretical foundation to study an issue. The former researcher provided a lot of theoretical perspective on PPP research, including fuzzy set theory, game theory, real option theory, agency theory, stakeholder management theory. Different theories for different research issues. The same research topic may also be explained from different theoretical perspectives. Fuzzy set theory was used to determine the concession period and allocate the risks [7, 27, 41]. Game theory was undertaken to identify risks, to analyze the government supervision mode, to identify the concession period [42] [43]; [44]. Real option theory was also used lot, it mainly to analyze the problem of government's guarantee in PPP projects or to increase the flexibility of the negotiation, or to recognize the real option value [45] [46] [47]

### ***comparative study***

The figure 6 conveys that comparative study was not frequently used by the researchers. Nevertheless, the conclusions resulted from comparative study often more powerful, and could help to effectively understand the various between different countries or regions, and different project types. Such as cross-country comparison between Australia and New Zealand evaluated the experience of school sector in these two countries [40]. A comparative evaluation of the policy and management of PPP among China, India, and UK not only provided reference for decision-making of PPP policy under specific national conditions of each country, but also enriched the global PPP knowledge [17]. Along with cross-country comparison, there are also cross-sector comparison studies. [48] provided comparative empirical evidence through the comparison of 39 traditional projects and 27 P3 projects in Canada from 2004 to 2016. To date, the comparative studies have not developed enough. Future research is needed to develop more comparison perspective and strategies.

### ***Research theme of PPP articles***

As stated previously the research on PPP has got significantly developed over the last several decades. Such as in construction area, from 1998- 2003 in the four selected journals, there were only three main subjects including risk management, procurement, and financial [15]. However, in 2009, the research domain extended to seven which identified from the articles published from 1998-2008 in seven assigned journals [4]. Until now, twelve categories and their subcategories for PPP research were summarized through a comprehensive content analysis in this study as shown in table 3. In general, the evolution of PPP studies can be summarized in following twofold:

(1) Some of the topic remain high interest by scholars around the world. Risk management, for instance, has been the most popular theme (shows in figure 7). Similarly with risk management, the application of PPP and its investment environment, economics viability and value for money (VFM), and procurement also have got much attention. Obviously, since these domains are crucial issues which directly determine the success of PPP projects. Take risk for example, a variety of risks fraught with each stage of the PPP project life cycle, and risk factors, the weight of the risk, and risk allocation plan could be different in specific project and the certain context of country. More risk factors identified and analysis like completion risk [49], revenue risk [10], climate risk [50-52], and design and construction risk [53] are needed and essential to the good performance of PPP. This is an extended study for the same problem from a wider level. The second focus is the introduction of novel research method and new foundation theory in these topics. For example, [54] developed a novel theoretical framework based on multiple prominent microeconomic theories which can be used to explain how property bundles are configured. In addition to the aforementioned two points, from different research lens to investigate the same topic to get in-depth understanding on the problems is another welcomed approach. To get a better idea for the PPP applications, [55] first aimed at exploration to the government compensation issues on retirement village projects.

(2) A series of new research topics have poured out. First is influenced by PPP external factors, to find an effective solution to satisfy the demands of the urban and economic development on a global scale. There are obviously, in recent years, abundant scholars have applied the concept of sustainability into the research of PPP. [56, 57] first time investigated sustainability in building projects from a whole life project

management perspective. [58] examined the critical success factors affecting the development of sustainable partnership under transitional conditions. Beyond that, also including the private sector's sustainable behaviors [48]; five-dimension sustainable performance measurements for PPP projects [21, 56, 57, 59] The second is addressed the problems of project level resulted in the new research domains. The typical example is the performance issue received a plethora of studies over the last few years. Substantial research on identifying the success factors [14, 23, 28, 45, 49], failure factors [10, 60], barriers [25], delivery challenges [61], in order to achieve the satisfactory performance, multiple performance evaluation framework and mechanism were prompted [59, 62-64]. What's more, some researchers try to study the suitability of PPP mode with new sectors, such as combination with the irrigation, forest protection, and tourist programs [65-68]. The third kind of new research topics drawn from crossover problems. For instance, from the relationship perspective to enhance the cross-sector collaboration [52] from the innovation lens to strengthen technological and institutional innovation [9, 55, 69, 70]; and improve negotiation and other communication management [64], final to reach a win-win goal and a best PPP practice.

Table 3

## Summary of PPP research topics

Topics	Subtopics
Risk management	Risk perception analysis, risk perception gap, risk identification, risk assessment (risk analysis, risk evaluation), risk allocation, risk allocation preference, risk mitigation; insurance program; completion risk, demand risk, design and construction risk, financial risk, policy risk, political risk, climate risk, residual value risk, revenue risk.
Communication management	Negotiation, contract negotiation, renegotiation, financial renegotiation, concession renegotiation, value of renegotiation, renegotiation strategy.
Contract management	Knowledge transfer, contract termination, contract clauses analysis, contract equilibrium, contractor selection, contract duration, contract design, delay causes, flexible contracts, early termination. SWOT analysis, failure path analysis.
Financial issues	Financial objectives, financial problems, financial conflict, financial model, financing forms, financial institutions, financial evaluation, financial assessment, financial viability, financing strategies, financial capability, finance trusts, financial framework, financing structure, payment mechanism, payment and audit mechanisms, value conflicts.
Economics viability and VFM	Government guarantees, revenue guarantee, feasible tariff, Payment and audit mechanisms, pricing framework, government equity investment, transaction cost, Government compensation guarantee, life cycle costs, bid cost, capital structure, internal rate of return, economic efficiency, capital markets, pricing and capacity, the value of flexibility, profit allocation, bargaining power, restrictive competition guarantee, excess revenue sharing ratio, economic feasibility, investment valuation, revenue sharing, value for money.
Governance related	Role of partners, government supervision, organizational governance structure, multi-objective decision making, role of national PPP Units, governance strategies, governance mechanisms, institutional analysis, Whole Lifecycle management, government accountability, harmonize strategic objectives.
Innovation	Technological innovation, innovative economy, institutional innovations.

PPP application and Investment environment	Culture, policy and management, PPP delivery method, viability of using PPPs, route selection, advantages and disadvantages analysis, incentive mechanism, approach selection, firms' willingness to PPP, concessionaire selection, criteria for select a partner, experience and lessons, portfolio strategy, multiple functions, legislative and administrative framework, regulatory framework, definition and types, daily practices analysis, motivation, support mechanisms, social capital intermediaries, user interests in PPP.
Relationship management	Objectives management, stakeholder management, manpower capability, trust, collaborative structure, management control, conflicts, interplay of relational and contractual governance, role of social actors, relationally integrated project teams, cross-sector collaboration, win-win solutions, Public-Social Partnership, cooperation among stakeholders, behaviors strategies.
Procurement	Concession period, procurement models, transfer phase, procurement innovation, tendering, briefing stage, concession selection, operation and maintenance Stage.
Performance	Barriers, difficulties, obstacles, problems, key affect factors, performance evaluative criteria, critical success factors, schedule delay causes, producing satisfactory outcomes, enhancement factors, driving and impeding factors, performance objectives, dynamic performance, failure drivers, performance predict, performance monitoring mechanism, opportunities, failure mechanisms.
Sustainable development	Sustainability performance, sustainable project management, sustainable contractor, financially sustainable strategy

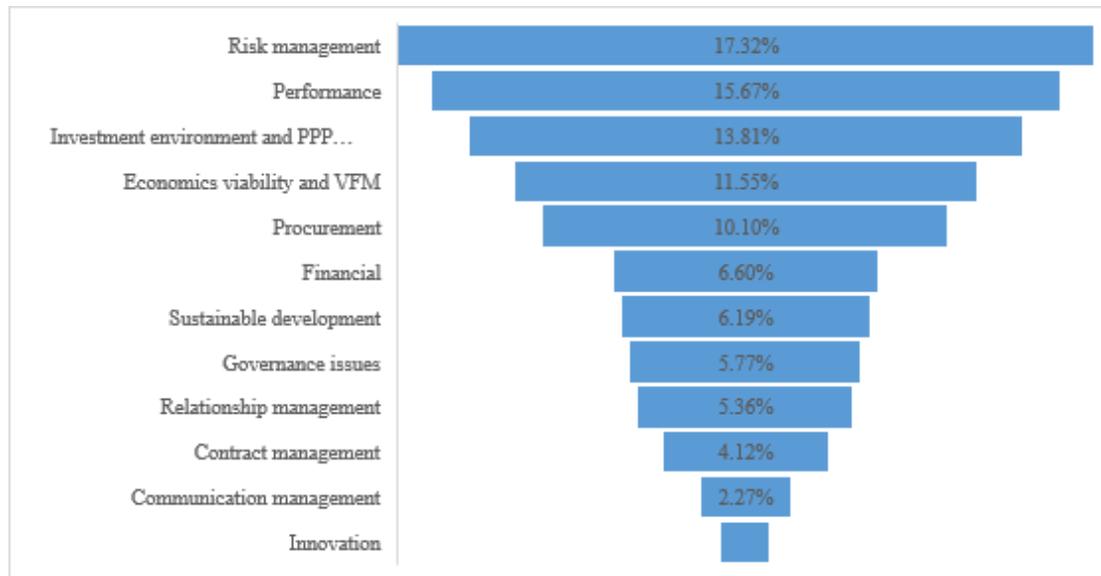


Figure 7. Distribution of research topics

## Conclusion

This study conducted a comprehensive review of PPP related articles which published in six selected journals namely, CME, IJPM, ECAM, JCEM, JME, SUS. From 1998 to the March of 2021, there were total 498 articles on the PPP issues. The results of the content analysis show that from 1998 to 2021, the PPP research can be divided into

three stage of developing, now it is increasing strongly throughout the world. The developing countries like China, India become a powerful new force. In particular, China become the country who contributed to the most publications on the PPP more than UK, HK, USA. The underlying reasons may be that these developing economies have a huge demand for infrastructure but are financial constrained. As a result, PPP as a very suitable solution has been vigorously promoted in these countries. While in terms of the project sectors, the PPP projects concentrated on the economic infrastructure, like transportation sectors; The coverage of social infrastructure projects realized by the mode of PPP is low compared with economic infrastructure, but there is a tendency to expand. Regarding the research method, case study and modeling were most used by PPP researchers, yet the Delphi survey and comparative study were insufficient. Both of these two approaches can be strengthened in future studies, especially the comparative studies, since which can provide a clear sense of the similarities and differences between the difference countries or regions, project sectors and other research themes.

Pertain to research domains, this research identified twelve themes. Risk management has been the most popular topic in the construction field. Other topics like procurement, economic viability and VFM, procurement, and PPP application and its investment environment, government related issues, and financial problems also got extensive attention in three ways. In addition, with the PPP applicated globally, and under the influence of factors internal or external the projects, there were some novel research topics appeared. For example, the sustainable development, PPP performance, and innovation were made a considerable exploration, the further research is also needed. To sum up, despite decades of research in the field, there are plenty of failures in practice, still some knowledge gaps that require constant effort and do further research by scholars.

This review only taken Scopus as the only search engine, and the publications analyzed only selected the five construction journals and SUS from 1998 to the March of 2021. It does not cover the full diversity of publications. Beyond that, screening papers and analysis manually involves a certain amount of subjective judgement. But the same standard used by the same researchers could be remove the variations. This study is still significant because this study makes several major contributions. Firstly, it carries out a comprehensive review of the PPP development and identified the research gaps, provides an insight and direction for further research. Secondly, the research findings are valuable, not only make the academic scholars and practitioners understand the status quo of PPP research, but also give a foundation for future comparative study of PPP topic with other sampling publications.

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