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A multi-disciplinary meta-review of the public–private partnerships research

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ABSTRACT

Public-Private Partnerships (PPP) research is very diverse. This field of research covers different topics across multiple disciplines and is disseminated in many journals. This has led to numerous review studies with a single discipline focus that apply mostly subjective or descriptive analyses. With the purpose of providing an integrated overview of all the disciplines that involve PPP and uncovering connections between these, this research provides an extensive PPP literature meta-review that uses objective bibliometric measures on 1,970 articles from 773 journals. The methodology involves ranking journals, identifying topical trends over 1989-2018, and clustering the literature to create a PPP knowledge map with associated research domains. The findings reaffirm that PPP is not only a multi-disciplinary research area, but also a self-contained meta-discipline that integrates some allied disciplines. The PPP meta-discipline is largely dominated by Construction Management and Economics (CME), Public Administration and Management, and Transportation Research disciplines, and integrates emerging topics such as sustainability, governance and stakeholders management. This study contributes to the CME scholarly community as it offers the first comprehensive meta-analysis of PPP literature and helps understanding PPP under the lens of a multi-disciplinary perspective.

Keywords: Bibliometrics; meta-review; literature review; Public-Private Partnerships; Private Finance Initiatives

Introduction

For about three decades, Public-Private Partnerships (PPP) have been receiving global recognition as institutional arrangements that can be undertaken to deliver and finance social facility and infrastructure projects. While some countries have selected the approach due to budgetary constraints and ineffective public procurement, others have chosen it for its operational and management efficiency and active private involvement (Osborne 2007, Chowdhury *et al.* 2011). The popularity of PPP can be observed in many developed, developing and emerging countries, and its effectiveness as an alternative approach to traditional public procurement has been proving its viability (*e.g.*, Marsilio *et al.* 2011, Yang *et al.* 2013, Charman and Narbaev 2017, Roumboutsos *et al.* 2017). However, despite the global growth of PPP, some studies note that empirical evidence of its benefits is unclear (*e.g.*, Marrewijk *et al.* 2008, Roehrich *et al.* 2014) and that its performance still remains contested due to challenges such as the complexity of procurement deals, the number of partners involved, project governance, cost escalations, renegotiations, and delays (*e.g.*, Guasch *et al.* 2008, Hodge and Greve 2017).

Along with the growth of PPP applications, there has been an increase in research into the field. This has spread into a variety of journals and research areas in a large span of different disciplines. PPP topics range from general and conceptual ones (*e.g.* PPP as a language game, as a governance tool, forms of PPP arrangements) to more sector-specific ones (*e.g.* critical success factors in infrastructure development, health care projects, economic development, build-operate-transfer type risks) (Van Ham and Koppenjan 2001, Marsilio *et al.* 2011, Javed *et al.* 2014, De Marco *et al.* 2017, Hodge and Greve 2017). Such a diversity in scholarly investigations may not only reflect that PPP covers multiple research interests, but it may also show that PPP research has stemmed from various disciplines: management science, public administration and political science (Mazouz *et al.* 2008), public

policy and administration, construction project management, and project finance (Kwak *et al.* 2009) are just some of these originating disciplines (Hodge and Greve 2017). As part of these disciplines, PPP emerged as a field of study out of two main research domains: on one hand, public policy and public finance and, on the other, construction engineering and economics, but limited cross-relationship was observed between the two areas (Hodge and Greve 2007).

Despite the fact that PPP attracts scholarly interest as an area of research with its body of knowledge, PPP topics differ across various journals and disciplines, and across the research domains pertaining to such disciplines. Moreover, there is an abundance of review studies on different disciplines that have analysed PPP literature in a particular focus area. For example, the health care management discipline has reviewed PPP in health care systems and the transportation discipline in transport research. For example, Wang *et al.* (2018) state that research issues in the public administration discipline are more at the macro-level partnership perspective while other disciplines, such as construction management and economics, focus on project performance and governance, which are at a micro-level analysis. Also, research emphasis is placed on either the private or the public sector according to the discipline that investigates the PPP contract arrangement.

This shows that PPP are important but very diverse and eclectic so that there is the need to attempt a meta-analysis in order to understand whether PPP can be considered as a self-contained integrated discipline by its own, considering its diversity across multiple disciplines, research areas, and journal sources. In order to fill this research gap, this study aims at figuring out whether PPP is a meta-discipline able to gather multiple contributions from various disciplines and diverse research areas, and combine them all into an integrated research framework. To achieve this, the research attempts to answer the following questions:

- 1) What are the top scholarly journals and main disciplines that publish PPP research considering its multi-disciplinary perspective?
- 2) What are the main PPP topics that have

been shaping the current state-of-the-art of PPP literature over the last three decades? 3) What are the main research domains (RD) with hot topics of PPP research across multiple disciplines and in relation to the main disciplines?

This research applies bibliometric techniques that are objective in their assessment, including journals ranking, topical trends analysis and classification of PPP research areas. The study makes three main contributions to the reviews on PPP literature. First, on the basis of the analysis of 773 literature outlets, a comprehensive ranking of journals is made available as a guide to understand a broader perspective of the output of the PPP field as represented by some of the main disciplines. Second, the PPP literature, which is represented by 1,970 papers across various disciplines, is mapped to assist the understanding of the overall scope of PPP research and is classified according to the main RDs and topical trends. Third, the present study adds a new multi-disciplinary meta-review perspective to the existing review-study genre discussed in the next section. As a result, the study opens discussions to understand whether PPP can be considered as a self-contained integrated discipline.

The rest of the paper is organised as follows. The next section presents a brief analysis of the past PPP review studies with the purpose of distinguishing the current review. Then, the research introduces its approach used to source the collected PPP literature, rank journals, reveal hot topics over time and classify the literature. The next section presents the results and groups them as a comprehensive journals ranking, PPP topics and a classification of the PPP literature into RDs. The study then discusses the main findings of the review. Finally, the paper concludes with a summary of the main results, the research limitations, future research directions and the benefits for both researchers and practitioners.

Previous PPP review studies

Given the wide scope of this study, it is worth noting that different governments and global

organisations use various definitions of PPP, and there is no consensus around the definition. Moreover, because of country-specific regulations and the lack of such definitional consistency, there are differences about what types of contract a PPP may embrace. For example, while some jurisdictions distinguish concession contracts from PPPs, others do not, and comprise concession contracts into PPP arrangements (Marques and Berg 2011). To solve this bias, this paper adopts the definition by World Bank, which broadly defines PPP as a long-term contract (including concession contracts) between a private party and a government entity, to provide a public asset or service, in which the private party bears significant risk and management responsibility, and remuneration is linked to performance (World Bank 2018).

While this section briefly reviews the scope, review approaches and findings of the previous works, Table 1 presents the key characteristics of these studies as well as of the current work. In light of what this paper addresses, the limitations of these studies can be grouped by focus discipline, review approach, covered period, and size of analysed literature.

Table 1 near here

The following three works focused their reviews on the Public Administration discipline. By applying a conceptual review approach by qualitative judgement, Hodge and Greve (2007) provided a first review of the field, evaluated the performance of PPP from an international perspective and concluded that there was still much disagreement and confusion in understanding PPP concepts. Marsilio *et al.* (2011) identified the intellectual structure of the field using bibliometric tools to conduct a citation analysis. They identified four main themes related to PPP: public administration, health care policy and services, planning and development, and urban studies. Wang *et al.* (2018) later identified four main streams of topics in the literature: the concept of PPP, risk sharing among PPP partners, drivers of its

successful adoption, and performance of the players. Although PPP is a popular way of delivering infrastructure and public projects, they found no general agreement in the above four topics as to what constitutes a successful PPP. Even though Marsilio *et al.* (2011) (analysed over a decade ago and covering the period of 1990-2007) and Wang *et al.* (2018) (reviewing 186 papers only) applied bibliometric tools (such as citation and author co-occurrence analysis) these studies focused on the Public Administration discipline with research issues that were more on the macro-level partnership perspective compared to PPP topics in the other disciplines (*e.g.*, the Construction Management and Economics discipline with the micro-level project perspective) the current study aims to cover.

The works by Ke *et al.* (2009), Tang *et al.* (2010), Zhang *et al.* (2016) reviewed the state-of-the-art of PPP research from the perspective of the Construction Management and Economics discipline. Ke *et al.* (2009) used a bibliometric analysis to evaluate the research against such criteria as annually published papers, authors' productivity, including their country of origin and affiliations, as well as the citations received by journals, papers and authors. This was one of the first works to apply citation analysis focusing on journals, papers and authors. From this perspective, they classified the PPP body of knowledge into seven categories, namely: procurement, economic viability, investment environment, financial package, governance issue, integration research and risk management. A systematic literature review of empirical and non-empirical PPP studies by Tang *et al.* (2010) recognised the importance of PPP construction topics in the construction industry, due to the evolving popularity of PPP arrangements for urban development. Zhang *et al.* (2016) reviewed PPP literature and compared publications in the Chinese and international outlet categories. The most prevailing research topics were contracting models for PPP and risk management. However, limited to one discipline, the findings of these works and classification of PPP topics resulted from applying bibliometric approaches, which were descriptive in their

analysis (such as the number of publications, distributions by country, affiliation and author) (Ke *et al.* 2009, Zhang *et al.* 2016) and a subjective systematic literature review (Tang *et al.* 2010).

Roehrich *et al.* (2014) applied a bibliometric (the number of publications by year and country) and content analysis approaches to review the health care management literature to provide a holistic view of PPP in healthcare delivery. They grouped the PPP literature into PPP policy, practice, and outcomes across macro, meso and micro levels of the health care management discipline. Torchia *et al.* (2015), using a bibliometric review (citation and author co-citation), suggested six main research streams in PPP: benefits, effectiveness, country overview, partners, efficiency and public interest. However both of these works reviewed the PPP literature in the health care sector only and published between 1990 and 2011.

Kwak *et al.* (2009) analysed the past literature to facilitate the understanding of the PPP contractual arrangements used for infrastructure development across various disciplines. Using a subjective assessment, they found five aspects of the PPP literature that could help understanding PPP characteristics: success factors and barriers, government roles, concessionaire selection, PPP risks, and PPP finance. Neto *et al.* (2016) found that journals in the engineering field were more active in publishing PPP research, with the majority of papers addressing issues pertaining to the transportation and health care sectors. In terms of topical coverage, most of the studies examined aspects related to contract design and performance/benefits as well as to risk sharing, while there was a lack of research on contract termination and renegotiation. This lack of research of PPP arrangements, with focus on their operations and maintenance or termination phases, may be due to the long-term horizon of such projects, which could have lasted two-three decades. In fact, it could be challenging to study a PPP project longitudinally, through continuous participant observation (South *et al.* 2018). However, if the former study used a systematic literature review with a subjective

content analysis and no specification of a source and dataset, the latter applied bibliometric measures which were descriptive in their assessment, such as the number of papers, the most cited papers, and journal titles, and did not offer a classification of the PPP literature into broader research domains or clusters.

The above list of PPP review studies reaffirms that the PPP field is very diverse and eclectic in nature with various topics and trends across various disciplines. With this confirmation on hand, the proposed bibliometric meta-review contributes to understanding whether PPP can be considered just as a miscellaneous area of practice or as an integrated meta-discipline. In other terms, the current study differs from available review works in three ways. First, the research draws on a substantially larger dataset of collected PPP articles (7,110 items) and covers the literature over the longer period of 30 years than the previous studies did. The records have been collected from journals evaluated and ranked on the basis of their number of publications and citation metrics. Second, given such a large dataset, in addition to citation analysis (also used in the previous studies), the study introduces other objective bibliometric types of analyses such as word frequency, relevance scoring and clustering. Third, unlike previous works that primarily focus on a particular discipline (except Kwak *et al.* (2009) but using a systematic literature review), this study adds a new perspective to the existing review-study genre by crossing different disciplines, such as Construction Management and Economics, Public Administration and Management, and Health Care Management, to just name a few.

Research approach and data

Data collection

As for the first step of the research approach (Table 2), PPP paper abstracts from the Scopus database were extracted to analyse the development and current state of the PPP literature.

The search query was performed using the advanced search field in Scopus. The search looked for publication titles, abstracts and the authors' keywords, considering the search terms "public private partnership(s)", "private finance initiative(s)" and "build operate transfer", thus further limiting the search to a "journal" source type in order to locate the core PPP literature in journals alone. Considering the fact that this study analysed PPP literature from a meta-perspective, the above-mentioned terms were specifically kept wide to obtain a broader picture of the PPP literature (*i.e.* its application and emergence in multiple disciplines). A more limited and specific search for PPP terms (*e.g.* contractual arrangement, health care public private partnerships, project finance) returned publications that were basically related to a particular discipline (*e.g.* construction management, public administration, transportation). This sourcing from Scopus was performed in January 2019 and it covered the 1967-2018 period. Overall, the search returned 7,110 records of PPP papers with the titles, abstracts, authors' keywords, citations and other bibliometric information.

Table 2 near here

The study performed a coverage comparison of the three publication and indexing databases: Scopus, Web of Science (WoS) and Google Scholar (GS). The authors compared the Scopus and WoS coverage of the PPP papers and found that the former provided about 20 percent more coverage, included more journals and had more international coverage and interdisciplinary areas than the latter, with respect to the PPP area. This result confirms the findings of Vieira and Gomes (2009) and of Mongeon and Paul-Hus (2016), who concluded that about 2/3 of these publications can be found in both databases, about 1/3 of them was found in only one database, and that Scopus covered more papers (which were only found in Scopus) than WoS (Vieira and Gomes 2009, Mongeon and Paul-Hus 2016). The authors also considered GS but, in addition to peer-reviewed journals, the search found journals that had

not been peer-reviewed and other types of sources like dissertations and proceedings. The authors also followed Harzing and Alakangas (2016), who found an increase in coverage in both GS and Scopus, but the latter only contained peer-reviewed publications and therefore provided an opportunity to evaluate publications of comparatively higher quality. In conclusion, the comparison proved that Scopus provides a wider coverage of PPP literature (than WoS), when the field is considered as multi-disciplinary (Vieira and Gomes 2009, Mongeon and Paul-Hus 2016), *i.e.* from a meta-perspective, and with higher quality publications (than GS).

Then, the abstracts of the chosen articles were read to establish their relevance to PPP research (Step 2 in Table 2). This thorough screening found some papers that were not relevant to PPP research, as they mentioned PPP in abstracts, *e.g.* when PPP was referred to as an outcome of new policy research, the authors emphasised the need for PPP to improve the economy of a city, which was not a research issue in itself. This resulted in a total of 1,970 articles published in 773 peer-reviewed journals between 1983 and 2018, which were then used for the analysis of citation and topics as well as for classification of the PPP literature. It emerged that the smallest number of PPP articles was published in 1983 (1 article) and the greatest number in 2016 (193 articles). The distribution of the number of PPP papers across journals was found to differ greatly. The top 10 journals, established on the basis of the number of published PPP papers, have published 456 papers, with the 1st journal in the rank having published 100 papers and the 10th – 22 papers. The top 50 journals had 867 papers (almost half of the dataset), the top 100 outlets published 1,090 papers and there were 508 journals that had only published 1 paper each.

Journal ranking procedure

In order to answer the first research question of the study it was first necessary to understand

which journals were the top ones, what disciplines those journals came from, and which of these disciplines prevailed in PPP research, in terms of research output and citation impact. In addition, the analysis of these journals was considered helpful to understand a broader perspective of the PPP field quickly, especially for new researchers (Ke *et al.* 2009). Given the diverse focus of these journals, stemming from subject areas such as business, management, accounting, engineering and medicine, and covering multiple areas of the PPP field, it was hard to select a starting point to determine the relevance of each journal for the research area primarily addressing PPP. Nevertheless, this study opted to consider a minimum number of 5 papers published in a journal as an initial threshold in order to select the journals for the ranking. The assumption of the study was that a threshold of 5 implied a consistent continuation of PPP papers over a period of almost three decades in a journal. Out of 773 journals in the dataset, 74 satisfied the threshold but 4 of them had discontinued coverage in Scopus by the year 2018. Finally, after excluding these 4 journals, 70 journals qualified for the journal ranking.

The study used eleven types of publication and citation metrics for the ranking: four citation-based metrics by Scopus, four by WoS and three related to the specific publication and citation patterns of the collected PPP papers (i.e. related to this study). The Scopus metrics included CiteScore (CiteS), the source normalised impact per paper (SNIP), the Scimago journal rank indicator (SJR) and the H-index of a journal. The metrics for the WoS database included the impact factor (JIF), the 5-year journal impact factor (5-JIF), the normalised eigenfactor (NEF) and the article influence score (AIS). The three metrics related to the publication and citation patterns of the collected papers were the total number of PPP papers in a journal (TPJ), which was considered to represent the relative productivity of a journal in the PPP field, the total number of citations of PPP papers in a journal (CitePJ), which was considered to reveal the relative influence of a journal in the PPP field, and the

average number of citation per paper in a journal (AvCitePJ), which was considered to show the weighted influence of papers. The reported values of the Scopus and WoS metrics refer to the year 2017 (officially reported in Spring 2018), while the values of the three measures related to the PPP papers refer to January 2019. Resort to such journal ranking measures in a particular discipline or research area has already been reported in a few studies. For example, Thongpapanl (2012) used the total citation score to rank technology management and innovation journals, while Elango *et al.* (2013) ranked nanotribology research journals using total paper and citation per paper measures.

This study adapted the approach by Willems and Vanhoucke (2015) (who ranked outlets in the project control area) for the journal ranking. Not all the journals had all metric values, because some were not indexed in Scopus and/or WoS database. All the journals had Scopus metric values, except one, which lacked the SNIP value. In WoS, 17 outlets had no JIF or NEF and 22 had no 5-JIF or AIS values. Therefore, a penalty score was assigned to the journals that did not have a value for a particular index. The penalty score was derived from the total number of outlets in the dataset (70) and the number of journals that had that particular index value. Moreover, in order to correctly position the outlets with that particular index score, the penalty score was fixed at an equal distance from the two values (70 and the number of journals with that index score). Overall, there were 22 journals maximum out of 70 that needed the adjustment for a given WoS metrics.

Results and analysis

Journal ranking

Table 3 presents the results of a calculation of a rank score for two example journals: one that misses some metrics, *Construction Management and Economics* (*i.e.* no JIF, 5-JIF, NEF and AIS), and the other that has all of the 11 metric values, *Public Management Review*. Since

Construction Management and Economics does not have the values for the above 4 indexes in the WoS database (*i.e.* only in the Emerging Sources Citation Index) its rank is adjusted with a penalty score. In fact, in order to place it in the ranking based on JIF, its penalty score for this metric is calculated against the number of journals that have JIF. As 53 journals have the JIF index, the associated penalty score is calculated as $53 + (70 - 53) / 2 = 62$, and this score is used to place the *Construction Management and Economics* journal in the JIF ranking.

Table 3 near here

Finally, the study computes the total rank scores for each journal on the basis of the individual scores or penalty scores of each index (Willems and Vanhoucke 2015). In order to rate each index equally, all the index scores received the same weight, and the total rank score of a journal was normalised to unity. Since there are 11 indexes, each of them is given a weight of 0.09, so that, when normalised to unity, they reach the unity. This means that the ideal best rank score is 1.00. However, none of the journals has a rank for each of its individual indexes equal to 1 (the top ranking for all the eleven indexes). The rank score for the *Construction Management and Economics* journal is 35.00 that is $0.09 * (37 + 37 + 33 + 16 + 62 + 59 + 62 + 59 + 4 + 3 + 13)$. Appendix A presents the ranking of the 70 journals according to two sets of metrics: the first that is based on the 3 metrics related to PPP papers/citations (indexes TPJ, CitePJ and AvCitePJ only), and the second that is based on all of the 11 metrics. The journals' productivity is also shown, in terms of the number of PPP papers published and the number of citations received.

PPP topics

The exploration of frequently-appearing topics allows gaining a deeper insight into what issues had and have been having a greater impact on a particular research field. In addition, it helps to reveal issues in bibliometric data, which in turn provide a useful perspective on how

the field is changing (Pollack and Adler 2015). The two techniques that were used to identify topical trends in the PPP field over the last 30 years were a keyword frequency analysis and keyword relevance scoring. The VOSViewer package, which was able to search for items from the corpus of the abstracts of 1,970 publications, was used in the analyses. Overall, the corpus was represented by 32,171 terms. Analysing such a large corpus of texts required some caution. Moreover, the decision to resort to choice of relevance scoring as a unit of analysis requires a further explanation. When a corpus of data is created, it is not normally desirable to include general terms that add little or no information to the PPP field. Terms with a high relevance value represent specific topics covered by the data (Van Eck and Waltman 2010). Therefore, the software, in addition to ranking keywords by their frequency of appearance, also ranks terms by their relevance scores. In addition to this objective assessment, the authors conducted qualitative evaluations of the corpus data, such as appropriateness of the terms to the PPP field and spelling checks. To do this, first, the terms in the body of the bibliometric data that did not represent the research issues in PPPs were disregarded. Second, the terms, which instead, showed the structure of a paper and common words, *e.g.* review, analysis, paper, survey, author, were determined by means of thesaurus filtering and were excluded from the corpus.

The total period (1989-2018) is equally divided into three sub-periods of 10 years each. Table 4 presents the most frequently encountered keywords that are in the literature, in terms of frequency and relevance score. In the past, PPP research mainly focused on contracting and funding issues and it was only later on that it began to address social aspects, such as the provision of better health care and educational services. More recent themes are value for money, capital structure, and guarantees.

Table 4 near here

PPP research classification into research domains

The classification of the PPP terms groups available literature into some prolific RDs and their associated topics. Such a classification of publication terms allows the relationship between the topics, which altogether make up the RD, to be visualised and evaluated. In such a case, one analysis unit could be the title of an article, the keywords, or the abstract.

Although titles are often used to attract the readers' interest and keywords can be classified by publishers, so that authors are requested to limit or pick from a selection of possible keywords, the search of a term in an abstract offers some flexibility in retaining the authors' meaning (Pollack and Adler 2015). Overall, for clustering purpose, the dataset of the PPP literature was represented by 28,593 terms that were extracted by means of the VosViewer tool from the abstracts of the 1,970 papers in 773 journals. The tool then attributed each term to a cluster, that is, a set of closely associated terms. A map with a network of interrelated terms was subsequently used to indicate central topics (from the relevance scores) and reveal any relationships between terms (Van Eck and Waltman 2010). The approach utilised an optimisation algorithm to build the relationship between the terms, using the relevance score measure of pairs of terms that had a close relationship. The algorithm had the task of revealing the shape of a network and of visualising it together with RDs around which such terms were centrally grouped (Van Eck and Waltman 2014, Heilig and Vob 2015).

The network of the RDs of the PPP literature was also built considering a qualitative assessment by the authors, which included the minimum number of keyword appearances and the minimum number of the threshold for a keyword. To do this, the terms without any significant meaning for the PPP field were disregarded using the above mentioned thesaurus filtering method. Finally, the clustering procedure resulted in the selection of the terms that appeared at least 10 times in the dataset, which formed the map of the 350 keywords. Finally, the paper then assigned a title to each domain in which the most prolific research issues were

outlined. The four RDs were constructed as shown in Figure 1. Clockwise, these are: partnership research in PPP (RD-1 with 67 terms), PPP public welfare research (RD-2 - 130), PPP worldwide diffusion research (RD-3 - 57) and PPP project research (RD-4 – 96). The domains have been found to shape the research into PPP. The generated map shows two important pieces of information. First, the number of links each term is connected to imply direct relationships with other keywords in the map. Second, the closeness of the terms to each other proves that closely related terms are located close to each other, whereas items located far away from each other show comparatively weaker relationships. It is suggested that, on the basis of the relevance scores of each term in the map, the domains of the PPP project research and the PPP public welfare research have the greatest impact on the PPP literature. These two domains are located far away from each other, compared to the PPP partnership research and the PPP worldwide diffusion research domains.

Figure 1 near here

Discussion

The main findings of this study can be subsumed into three main categories, which are associated with the main research questions of this study.

PPP journal ranking and disciplinary base

The comprehensive ranking of the 70 well-known journals (Appendix A) reaffirms the multi-disciplinary nature of PPP research. The analysis of the journals was performed considering the total rank scores, the total number of published papers, the total citations these papers received, and the citations per paper. The analysis of the journals considering the total rank score reveals a clear dominance of the following five disciplines: Construction Management and Economics (CME), Public Administration and Management (PAM), Health Care

Management (HCM), Economic Development (ED) and Transportation Research (TR). These disciplines are represented by more papers and journals than any other disciplines, namely: Resource Management, Utility and Water Resource Management, Supply Chain Management and Logistics. The analysis, in terms of the number of published papers, results in a clear dominance of CME, followed by PAM and TR. CME, PAM and HCM disciplines are in the top three positions, based on the total number of citations ranking. Although care should be taken when classifying the ranking list according to disciplines; the paper attempts to offer a first meta-ranking of PPP literature by journal title. Irrespective of the PPP area of research, this ranking serves the purpose to understand a broader perspective of the output of the PPP field as represented by some of the main disciplines, especially for new researchers.

Generic PPP topical trends

The analysis of the most important PPP topics that have been researched over time by the international community of scholars is presented in Table 4. It considers the most frequently occurring terms and their relevance scores in the PPP literature. During the 1990s, the main hot topics were those associated with some general aspects of PPPs such as funding/financing and contracting effectiveness of PPPs. In the early 2000s, researchers started to shift their interest towards more specific problems inherent with uncertainty, risk and risk transfer in PPPs. Roehrich *et al.* (2014) noted that research into risk sharing played a crucial role for achieving value for money, and questions of risk allocation between the public sector and the private sector was debated. Also, emphasis was placed on specific sectors such as the provision of effective health care services, and the efficiency of the public and private sectors for social services. These research issues were aimed at establishing how to enable PPP players to develop an effective partnership in order to achieve public goals (Wang *et al.* 2018). In the 2010s, research moved towards project-level techniques and tools for financial

viability and evaluation including value for money, capital structure, cash flow analysis, and guarantees. Overall, the analysis of the most frequent and relevant topics over the last three decades suggest that PPP research has evolved as a funnel from general issues to the study of specific techniques to enable value creation in PPP. These multiple trends demonstrate that research from the disciplinary fields of contracting, public administration, finance, risk management, as well as construction and transportation has been integrating over time to offer a larger multi-disciplinary perspective on PPP.

Research domains of the PPP field

Table 5 summarizes the key research problems, disciplinary bases, main theories, typical research methods, and main research directions across the RDs of PPP. To study a given research problem, researchers take from different theories in a way that each RD lies on its specific main disciplinary bases and theoretical lenses , which bring these contributing theoretical lenses. Under these disciplinary perspectives, some classical theories play a crucial role as to dominate in and contribute to most of the PPP research fields. While some disciplines bring their own theories which are unique to a given RD, other theories are used across multiple RDs. What is interesting is that each discipline has its own perspective and theoretical lens to investigate the PPP meta-disciplinary research field.

The key research problems in PPP and most common methods used by scholars are selected based on the analysis of the 350 terms and their relevance scores and frequency (appearance) across RDs. The results given in the table should not be considered exhaustive but they highlight the key elements of each RD and show the breadth of their application, as discussed below.

Table 5 near here

RD-1 – PPP partnership research

This domain focuses on research issues related to partnership in PPP (Table 5). Establishing and maintaining an effective collaboration between the public and private sectors as well as engaging with different stakeholders within a PPP system is one of the fundamental areas of PPP research. Yet, this domain has only a coverage of about 19.2% of the relevant PPP terms in the PPP literature map (Figure 1). The perspective adapted to study the partnership problems vary from government support and regulation, partnership governance and trust, public accountability, stakeholders management and environment, to value for money and risk management. The domain's perspective is to look at the PPP phenomena as a framework in which multiple stakeholders cooperate.

Regarding the main disciplinary bases, PAM researchers look at the PPP concept at the wider level of policies that governments can use and pay more attention to social issues, societal benefits, governance and legitimacy of the PPP concept. For example, former scholars approached PPP as a social environment and explored both external and internal social structures of PPP from the perspectives of the public sector, the private sector, and other stakeholders (Zhang and Jia, 2010). The contract theory was used in both CME and PAM disciplines. While CME folks took this theoretical lens to empirically investigate financial benefits for a contracting organization, PAM used it to analyse and enhance possible multiple effects (managerial, social, and environmental) to all parties involved in the partnership. The complexity theory was used to understand effective collaboration with governmental and other public agencies, and stakeholder satisfaction was one of the contributing factors used to evaluate the partnership externally. One of the key research problems of this domain pertains to a governance framework of PPP as it has always had an inherent governance dimension (Hodge and Greve 2017). Also, effective governance institutions and regulatory quality would increase the performance of the partnership as the

lack of certain crucial elements of good governance has a negative influence on the growth of PPP potential (Cui *et al.* 2010).

RD-2 – PPP public welfare research

The RD-2 is about the PPP public welfare research. It focuses on the impact of and expectations from PPP arrangements with the public sector. PPP services are directed towards solving social problems in education, health care and utility systems. This type of research looks into the benefits for the society rather than profit for the project partners. Topics related to governmental support, in order to facilitate PPP, including the creation of favourable investment environments and regulatory frameworks, as well as support from global donors, are addressed in this domain.

Researchers in HCM discipline, taking theories like the patient-centred theory or sustainability theory, look at PPP as a mechanism to more effectively and efficiently finance and operate health care facilities. HCM scholars noted that traditional procurement approaches may create impediments for effective delivery of health care facilities and services because of limited contractor capacity compared to project size, high transaction and maintenance costs throughout project life cycle (Roehrich *et al* 2014). This would bring limited integration between clinical service models and health care infrastructure design and delivery with limited innovation in new build healthcare PPPs (Barlow and Köberle-Gaiser 2009). In PAM discipline, taking the new public management theory helped to address PPP agenda more effectively. This theory supported the adoption of private sector approaches and market competition such as stronger contracts, better performance measurements, and detailed output specifications with an outcomes focus (Hodge and Greve 2017).

RD-3 – PPP worldwide diffusion research

The domain on PPP worldwide diffusion research (RD-3) addresses the problems of implementing PPP in various countries and regions as the demand for PPP products is in rise due to both urbanization and economic growth. Some hot topics address the rise of PPP in developing countries as well as the economic development of countries and regions through PPP infrastructure projects. In particular, this domain typically emphasises PPP from a country perspective or through a link with a specific nation.

The PPP field in this domain are mainly approached through the lens of economic and development studies and its research problems are addressed with theories associated with ED discipline. Economics and urban development folks, using, for example, new institutional economics theory, see in PPP a solution to wider social and economic problems such as sustainable economic growth or unemployment in a region or particular jurisdiction. A considerable number of ED publications shift their interest to implement sustainability concepts into their research. Examples are taking the theoretical aspects of sustainable PPP development to address the 2030 United Nation's Agenda for Sustainable Development and Sustainable Development Goals which cover all crucial policy areas to secure a sustainable future including education, health, economic development, social protection, environmental protection, and natural resources governance (Marx 2019).

RD-4 – PPP project research

Finally, RD-4 addresses issues arising at the project level of a PPP arrangement. Together with RD-2 (PPP for public welfare), this domain has the highest number of terms (27.4%) in the PPP literature map (Figure 1). The topics vary greatly and range from the characteristics of PPP projects, such as the financial structure of a project, design-construction problems, the project phases and life-cycle assessment, to performance management concepts, such as cost,

time and scope management.

Scholars in CME are likely to see the PPP phenomena at the level of a project and organizational delivery form. They tend to explore project performance, success factors, revenue and property rights issues. For example, the capital budgeting theory with its tools like the payback period, discounted cash flow analysis and net present value was used to assess the financial viability of a PPP project and to design its effective capital structure (Zhang, 2005). To study PPP project bidding, concessionaire selection, and procurement issues, former researchers used real options theory and contract theory. The real options was used to guarantee revenue from the PPP investment under a given contractual right, to evaluate various incentives offered by government and to model a most optimal concessionaire period (Alonso-Conde et al. 2007, Carbonara *et al.* 2014, Lv *et al.* 2015). Decision theory and uncertainty theory with sensitivity analysis and scenario analysis were widely used to address risk allocation and to select a most suitable PPP model (e.g., between build operate transfer and build own operate transfer forms). Both CME discipline and TR discipline share similar theoretical lenses on PPPs, but the disciplinary base of TR was specific to investigate challenges facing transport infrastructure and how PPP can provide more sustainable transportation services, generate revenue, and improve traffic and connectedness of cities and regions (Sollno and Santos 2010, Transport Reviews, Dowling and Kent 2015, Transport Policy). Unlike scholars of other disciplines, TR scholars in their publications make more emphasis on PPP as an instrument to build and operate road infrastructure projects and different modes of transportation both in developed and developing countries.

Cross-domain relationships

If one crosses the findings obtained from the PPP literature clusters (Figure 1) with the main

disciplines of PPP research (Table 5), it can be noted that CME and TR disciplines dominate, in terms of research contributions, in both RD-1 and RD-4. Some considerations may be drawn from this empirical observation: the CME and TR disciplines have been extending the span and increasing the quantity of studies in PPPs not only because of the growing importance of PPPs as a mechanism to develop facility and transportation infrastructures worldwide, as empirically observed, but also because of the ever growing impact of governance and financial systems for the development of capital asset projects as explored in the PPP partnership research (RD-1) and the PPP project research (RD-4). Conceptually, CME and TR have been evolving as to include PPP's RDs as integral and structural parts of their bodies of knowledge. The papers in journals in the HCM discipline are continuing to have a great impact on the domain of topics related to the PPP public welfare research and the PPP worldwide diffusion research. The PAM discipline will contribute more to RD-1 and RD-2, while the ED discipline will continue to produce papers about international diffusion in RD-3. In addition, the CME and TR disciplines will continue to emphasise the private sector perspective and its associated topics (e.g. project-level issues, procurement, concessionaire, infrastructure), while the PAM and HCM disciplines will emphasise the public sector perspective (e.g. social need services, government support, regulatory framework).

Main implication and further research avenues

Main implication

The above considerations, related to possible co-evolutions of PPP's RDs and associated disciplines and theories, may suggest that PPP is evolving as a meta-discipline per se, which integrates elements of multiple disciplines into relevant topics (specific to PPP research) and combines them into a self-contained integrated research framework. Overall, the findings of

this work are significantly different with the findings of the previous PPP review studies (Table 1) which were limited to one discipline, used other review approaches (mainly a subjective literature review or descriptive bibliometric measures), and covered a smaller dataset of PPP papers.

Further research avenues

Based on the analysis of the extension of PPP literature, its topical trends, the domains of the PPP research with their research problems as well as foundational disciplines with their associated theories, the study suggests some main future research avenues. Research issues in these streams are likely to continue or to emerge in the future. Also, these research directions should be considered as evolving in different literature dimensions as the study approaches PPP from a meta-perspective originating from multiple independent disciplines and across multiple RDs.

Research avenue 1. Stakeholders and sustainable partnership in PPP. Some of the topics in current PPP research, such as sustainability and governance issues, are expected to emerge in the near future. Such topics are focused on creating and maintaining sustainable cooperation for the public and private sectors through economic, social and environmental aspects. In particular this is going to be achieved through more sustainable PPP governance, involving various stakeholders. Such an involvement is important because, from the perspective of value creation for the stakeholders, the success of a PPP arrangement depends on how governments address the stakeholders' interest during the bidding stage of a PPP project (Mouraviev and Kakabadse 2015). The research into tendering and contracting is still on the rise, and issues such as competition, negotiation and guarantees require an effective architecture in a PPP framework. Such issues are complicated, because establishing a PPP requires longer tendering and negotiation periods compared to traditional public procurement

models (Reeves *et al.* 2015). Effective collaboration with governmental and other public agencies, and stakeholders satisfaction are some of the contributing factors that can be used to evaluate a partnership externally, while establishing and managing a special purpose vehicle with clients, contractors, and other supporting agencies, are topics that can be considered to investigate PPP efficiency internally. In addition, it would be opportune to study a balance between the public sector (social and budgetary objectives) and the private sector (profit margins and business extension). In this regard, cooperation between the two parties within a PPP framework is often expected to generate the desired service or a product for the public sector, together with the expectation of financial benefits for the private sector.

Research avenue 2. Improved PPP project performance. The economic feasibility and value for money evaluation are key methods involved in the selection and scoping of PPP initiatives, which pay more attention to financial and economic effects rather than social effects (Cui *et al.* 2018). The research should continue to analyse and develop key performance indicators to measure project success. The study acknowledges that in PPP, there are different dimensions of success, from the project level and organizational form, to the economic and/or political entity in a given jurisdiction. Research in this group is at the project level. The performance evaluation can be further investigated based on project ex-post or real-life process-based assessment system. The integration of information technology tools into the project performance helps to meet ever growing requirements of PPP players and governments. For example, the research to adapt building information modelling frameworks into the PPP project performance measurement system may help to record its history over multiple years of project construction and operation. Along with this, further studies can concentrate around how to address sustainability issues as part of required performance reporting of PPP projects. More traditional topics of reducing project cost and meeting agreed schedules under influence from multiple stakeholders and project owners

such as adhering to new or updated requirements and change requests will continue in the future. Also, considering that the majority of papers in the dataset have dealt with design and development phases of a PPP arrangement, further studies could explore how PPP projects develop over their life cycles, with focus on the operational phases. This could be part of a research into facility management that focuses on the maintenance of constructed PPP projects.

Research avenue 3. Government support and regulatory framework for PPP.

Governments offer strong incentives to use PPP to fill funding gaps and management gaps, and PPP play a significant role in attracting investments to public service and infrastructure projects. Also, the process of using PPP itself develops a business friendly environment, and establishing and maintaining a sustainable government support and regulatory framework can therefore create a path for the development of an attractive investment climate (Charman and Narbaev 2017). This may lead to the skills and financial instruments developed for PPP to be equally applicable to a range of other government investment initiatives. Some of the issues which can be explored in this direction are legislation for special economic zones, allocation of control rights, transparent mechanism for dispute settlement and oversight requirements, enabling government to monitor pricing, services and operations. Strong governance institutions with transparent and clean regulatory system, which serve a PPP consortium, enhance PPP performance and investment growth. The claim, that the PPP phenomena and success at the macro level (as a political governance tool or policy instrument) still remains contested (Hodge and Greve 2017), may urge the need for future studies. PPP as a public policy system has a direct relation with the political environment of the host country (Cui *et al.* 2018) and the lens of political support to approve and intensify PPP initiatives is one of the crucial factors for success of PPP. Therefore, the research into stable and transparent

government support and regulatory quality is a necessary stream to understand PPP phenomena and success from a macro perspective and country context.

The next research streams can also be considered. First, future research could analyse the type of research, the applied methods, the empirical and normative papers used in the five identified disciplines and the four domains of the PPP research. Second, it is promising to conduct a deeper analysis of the evolution of PPP by associated disciplines and to explore discipline-specific issues. For example, it would be possible to study the types of PPP projects by sector, contractual forms of PPP arrangement across countries and regions, and PPP as a language game to address the lack of definitional consistency. Lastly, more of scientometric (bibliometric) measures can be used to analyse the PPP literature, which can include co-occurrence of keywords, author network analysis and bursts detection.

Conclusions

Previous review studies on Public-Private Partnerships (PPP) were primarily specific to a particular research area and applied mainly subjective or descriptive analyses. This study presents a comprehensive review of PPP literature over the last three decades, with reference to multiple disciplines, and takes into account the diversity of journals and topics. Using objective bibliometric techniques to conduct the ranking of journals, the analysis of topical trends, and the classification of the PPP field into research domains (RD) across various disciplines, this work has reviewed 1,970 papers and it offers a new multi-disciplinary perspective to the existing review-study genre.

The main results of this study can be summarised as follows. First, the ranking of 70 well-known journals suggests that Construction Management and Economics (CME), Public Administration and Management (PAM) and Transportation Research (TR) disciplines will continue to produce more papers in the PPP field, while journals in the CME, PAM and

Health Care Management (HCM) disciplines will remain at the top of the ranking list, and will continue to receive more citations. Second, the analysis of the PPP topics over the last 30 years, subdivided into 10-year periods, shows that the focus at the beginning of the PPP research (1990s) was on construction, contracting and funding aspects of PPP arrangements, and only later (2000s) did it begin to address the social aspects of PPP for health care and education, and in developing countries. In the 2010s, the trend was on evaluating value for money, capital structure and guarantees. The issues of sustainability, governance and stakeholders, which are focused on creating and maintaining a more sustainable cooperation for the public and private sectors through their economic, social and environmental impacts, are emerging topics in the PPP field. Third, based on keywords relevance scoring, the clustering process generated a PPP research map with 350 terms and classified the literature into four RDs: PPP partnership research, PPP public welfare research, PPP worldwide diffusion research and PPP project research. It was found that the RDs of the public welfare research and project research have a greater impact on PPP literature than the other two, and are expecting to shape the future research in the field. This paper, by proving that PPP topics substantially vary across various journals, disciplines and RDs, deals with PPP by considering it as originating from the above disciplines, across multiple domains and from a meta-perspective. Overall, the analysis allows to qualitatively state that PPP can be considered as a self-contained meta-discipline that integrates contributions from multiple research domains and associated disciplines, mainly CME, PAM and TR.

The research suffers from some limitations, and the consideration of these limitations could help to pave the way towards the future research directions presented above. The RDs and disciplines have been based on a dataset of journals that addresses to different types of readers and cover various topics of interest. Also, care should be taken into account because

the representation of the disciplines in different types of journals is not exclusive and they may overlap.

Regardless of the PPP's RD they are engaged in, the findings of this review paper are of interest to researchers who are interested in understanding how research into the PPP field (as a self-contained meta-discipline) is evolving at a meta-level and across various disciplines. Practitioners, either in the public or private sectors, may take advantage of the findings to understand the development of PPP in various sectors of application.

Data availability statement

The data that supports the findings of this study are openly available in Figshare at <http://doi.org/10.6084/m9.figshare.7750841>

Disclosure statement

No potential conflict of interest was reported by the authors.

List of acronyms

5-JIF: 5-year journal impact factor

AIS: Article influence score

AvCitePJ: Average number of citations per paper in a journal

CitePJ: Total number of citations with reference to PPP papers in a journal

CiteS: CiteScore

CME: Construction Management and Economics discipline

ED: Economic Development discipline

H-index: H-index of a journal

HCM: Health Care Management discipline

JIF: Journal impact factor

NEF: Normalised eigenfactor

PAM: Public Administration and Management discipline

RD: Research domain

SJR: Scimago journal rank indicator

SNIP: Source normalised impact per paper

TPJ: Total number of PPP papers in a journal

TR: Transportation Research discipline

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Table 1. A summary of the past and current PPP review studies.

| Study | Initial size | Period | Review source | Primary discipline focused | Review approach |
|-------------------------------|--------------------|---------------|--|---------------------------------------|--|
| Hodge and Greve (2007) | n/a | n/a | n/a | Public administration and management | A conceptual review |
| Ke <i>et al.</i> (2009) | 170 articles | 1998-2008 | Seven leading construction management journals from Scopus | Construction management and economics | A systematic literature review; A bibliometric analysis |
| Kwak <i>et al.</i> (2009) | n/a | Last 20 years | n/a | Multi-disciplinary | A systematic literature review |
| Tang <i>et al.</i> (2010) | 107 articles | 1998-2007 | Six leading construction management journals | Construction management and economics | A bibliometric analysis |
| Marsilio <i>et al.</i> (2011) | 323 | 1990-2007 | Web of Science (188 journals and 25 books) | Public administration and management | A bibliometric analysis (citation and author co-citation) |
| Roehrich <i>et al.</i> (2014) | Over 1400 articles | 1990-2011 | Web of Science | Health care | A systematic literature review (content analysis); A bibliometric analysis |
| Torchia <i>et al.</i> (2015) | 46 articles | 1990-2011 | Web of Science, Ebsco Host | Health care | A systematic literature review (content analysis) |
| Zhang <i>et al.</i> (2016) | 899 articles | 2005-2014 | CNKI (Chinese search engine for Chinese journals); Scopus (for international journals) | Construction management and economics | A bibliometric analysis |
| Wang <i>et al.</i> (2017) | 186 articles | 1983-2016 | Web of Science | Public administration and management | A systematic literature review (content analysis); |
| Current study | 4,540 articles | 1967-2016 | Scopus | Multi-disciplinary | A systematic literature review; Journal ranking by weighted metrics; Bibliometric analysis (citation and topics); Objective clustering by keywords |

Table 2. The multi-disciplinary meta-review approach of the PPP literature review.

| Steps | Action and output |
|--|---|
| 1. Abstracts collection | <p>Action: search for a term “public-private partnership(s)”, “private finance initiative(s)” and “build-operate-transfer” in titles of articles, abstracts and author keywords in Scopus.</p> <p>Output: returned 7,110 abstracts.</p> |
| 2. Abstracts screening | <p>Action: read and filter abstracts for relevancy to the PPP literature.</p> <p>Output: selected 1,970 papers published in 773 journals.</p> |
| 3. Ranking of journals and analysis of disciplines | <p>Action: out of 773 journals select the journals with at least 5 papers and rank them according to 11 metrics: Scopus (4), Web of Science (4) and the study (3).</p> <p>Output: the top 70 journals by citation metrics and paper productivity.</p> |
| 4. The PPP topical trends | <p>Action: using a keyword frequency and relevance scores, identify PPP terms.</p> <p>Output: the most occurring and relevant PPP topics over the last three decades.</p> |
| 5. The PPP research classification | <p>Action: classify the PPP literature (represented by 1,970 papers) into research domains.</p> <p>Output: the PPP literature map with its four research domains, hot topics and related disciplines.</p> |

Table 3. Calculation of rank scores for sample journals.

| Journal | Metrics Scopus 2017 | | | | Metrics WoS 2017 | | | | The study metrics (January 2019) | | | Total rank score |
|--|---------------------|------|------|-------------|------------------|-----------|------|------|-------------------------------------|--------|------|------------------------|
| | CiteS | SNIP | SJR | H- index | JIF | 5- JIF | NEF | AIS | TPJ | CitePJ | ACPJ | |
| <i>Construction management and economics</i> | | | | | | | | | | | | |
| Metrics | 1.66 | 1.03 | 0.82 | 74 | n/a | n/a | n/a | n/a | 58 | 2,225 | 38.4 | |
| Rank | 37 | 37 | 33 | 16 | 62 | 59 | 62 | 59 | 4 | 3 | 13 | 35.00 |
| <i>Public management review</i> | | | | | | | | | | | | |
| Metrics | 3.31 | 1.93 | 1.63 | 43 | 3.15 | 3.09 | 0.33 | 0.69 | 18 | 287 | 15.9 | |
| Rank | 15 | 14 | 16 | 31 | 13 | 18 | 24 | 20 | 11 | 19 | 30 | 19.18 |

Table 4. The top 10 most occurring and relevant terms.

| Rank | 1989-1998 (of 1,740 terms) | | 1999-2008 (of 8,258 terms) | | 2009-2018 (of 22,173 terms) | |
|------|-------------------------------|------------------------|-------------------------------|-------------------|--------------------------------|---------------------------|
| | Frequency | Relevance | Frequency | Relevance | Frequency | Relevance |
| 1 | Private sector | Infrastructure project | Risk | Private sector | Civil engineers | Minimum Revenue Guarantee |
| 2 | Service | China | Transfer | Concession period | Resource | Public administration |
| 3 | Policy | Construction | Resource | Health | Organization | Real option |
| 4 | Infrastructure project | Concession | Infrastructure project | Risk transfer | Economy | Monte Carlo simulation |
| 5 | Model | Financing | Organization | City | China | Public Sector Comparator |
| 6 | Construction | Funding | Operation | Education | Governance | Capital structure |
| 7 | Financing | Contractor | Scheme | Uncertainty | Region | Highway project |
| 8 | Concession | Public sector | Public service | Money | Program | Net Present Value |
| 9 | Public sector | Central government | Procurement | India | Uncertainty | Toll |
| 10 | Funding | Asset | Financing | Construction | Private investor | Financial viability |

Note: The period of 1989-1998 considers also 5 papers published before 1989: 1983 (1 paper), 1987 (2) and 1988 (2).

Table 5. PPP Research Domains (RDs) with relevant topics and main related disciplines.

| PPP research domains (terms) | RD relevant topics (areas of interest) | Main related disciplines |
|--|--|--------------------------|
| RD-1 – PPP partnership research (67) | Award, best practice, bid, consortium, critical success factors, decision making, early stage, implementation, life cycle, policy maker, political environment, stakeholder, procurement process, public sector comparator, risk allocation, Special Purpose Vehicle, transaction cost economics, value for money | CME, PAM, TR |
| RD-2 – PPP public welfare research (130) | Accounting, child, city, decease, education, farmer, health service, hospital, local community, NGO, poverty, private actor, privatisation, public good, reforms, regulatory framework, sanitation, social development, sustainable development, utilities, waste, water supply, World Bank, World Health Organisation | HC, PAM |
| RD-3 – PPP worldwide diffusion research (57) | Brazil, Canada, Competitiveness, debt, developed country, economic growth, European Union, financial support, government, institutional environment, global financial crisis, Greece, highway, Italy, new forms, port, road, public partners, South Africa, transport infrastructure, UK, USA | ED, HC, |
| RD-4 – PPP project research (96) | BOT contract, capital structure, concession agreement, concessionaire, construction project, construction risk, delay, duration, estimation, financial viability, highway project, infrastructure project, minimum revenue guarantee, Monte Carlo simulation, Net Present Value, PPP model, probability, real option, risk analysis, sensitivity analysis, toll, uncertainty | CME, TR |