Lima, S., Brochado, A. & Marques, R. C. (2021). Public-private partnerships in the water sector: A review. *Utilities Policy*. 69.

Public-private partnerships in the water sector: A review

Abstract

Public-private partnerships (PPPs) offer possible solutions for governments seeking to achieve better value for money and fund the investments needed to provide infrastructure and manage public services. Water-sector projects demand extensive, up-front and sunk investments, and inefficiency levels are often significant. This study conducted a systematic review of previous research on water sector PPP projects. The research design is innovative in that it relied on a hybrid methodology combining systematic quantitative, semantic network and narrative analyses. The literature review protocol applied found 122 relevant studies published in top journals. Five key topics within water-related PPP studies were identified: risk management, PPP contractual arrangements, financing and tariffs, infrastructure, and governance. The most important topic is risk management, within which individual scholars' contributions were tracked. However, a consensus has not been reached about the best risk matrix for improving PPP contracts in the water sector.

Keywords: Public-private partnership Systematic literature review Water sector

1. Introduction

The Sustainable Development Goal (SDG) 6 defines the targets that ensure the availability and sustainable management of water and sani- tation services for all until 2030. In 2017 water services reached nearly 70% of the world population whereas sanitation covering 45% (JMP, 2020). Access to water and sanitation services is a core issue that pre- sents major social, economic and environmental challenges, as well as an essential component of human development (Tortajada, 2014).

Moreover, urban water utilities are often inadequately managed, and many customers' quality of life is diminished due to inadequate or even non-existent services (Vedachalam et al., 2016). Massive investments are required to overcome the status quo, and the private sector can play a decisive role here through public-private partnership (PPP) projects.

A PPP arrangement is a type of strategic alliance characterised by long-term contracts between public and private partners, where the private partner usually designs, finances, builds and operates the infrastructure or the service (Yescombe, 2007). PPP arrangements for large and complex infrastructure projects combine competitive tendering and negotiation processes to improve efficiency and monitor and allocate risks between the public and private sectors (Yu et al., 2018).

Over the last two decades, the literature on PPP projects has been growing due to the number of published articles, including a variety of research methods and topics (Cui et al., 2018). Governments need to secure reliable water infrastructure but often lack the internal capacity to achieve this goal, increasing the attractiveness of PPP arrangements in the water sector. This sector's demands also require intensive, up-front and sunk investments and inefficiency levels are often significant, making PPP projects a viable, fitting option (Marques and Berg, 2011a; 2011b). This type of strategic alliance has emerged as an attractive solution to achieve these objectives, especially in developing countries (Idelovitch and Ringskog, 1995).

Asymmetrical information – including moral hazard and incomplete contracts – is

a natural concern addressed by the literature over the years (Fang et al., 2009; Fernandez et al., 2018; Hajjej et al., 2017; Owusu-- Manu et al., 2018; Vinogradov and Shadrina, 2018). Public versus private ownership brings up a further important issue of residual control rights. These legal features can be crucial to the lack and poor delivery of contracted services or infrastructure (Hart, 2017).

Contract terms may include the design, construction, maintenance and operation of public infrastructure by private-sector parties (Yescombe, 2007). Overall, a PPP can be categorised into one of three groups. The first is based on the assets involved, namely, projects involving building (i.e., greenfield) or rehabilitating and upgrading (i.e., brownfield) infrastructure. The second group is centred on the re- sponsibilities allocated to private parties with regard to design, construction or rehabilitation, finance, maintenance and operation. The last group focuses on how the private parties are paid: by direct consumers, the government, or both (World Bank, 2017).

Previous researchers have performed systematic literature reviews focusing on PPP studies (Marsilio et al., 2011; Ke et al., 2009; Neto et al., 2016; Cui et al., 2018). For example, Marsilio et al. (2011) conducted a bibliometric analysis covering the 1990–2007 period and identified four main fields within PPP research's intellectual structure. These included government and intergovernmental organisations, public administration and public policy academics, new institutional economics scholars, and strategy and network theory scholars.

Ke et al. (2009), in turn, carried out a systematic literature review related to PPP arrangements between 1998 and 2008. The cited authors expanded the three traditional risk and financial issues to seven cate- gories: investment environments, procurement, economic viability, financial packages, risk management, governance issues and integration research. Andon (2012) analysed the relevant PPP literature published up to December 2010. The results suggest the need to look beyond the 'technicalities' of these partnerships to question critical explanations, internalise knowledge and consider post-procurement implications and existing regulation and guidelines.

Neto et al. (2016) also conducted a bibliometric analysis of studies completed between 1990 and 2014, concluding that researchers had focused mainly on contract design, performance and risk-sharing and less on areas such as contract termination and renegotiation. In a related study, Chen et al. (2016) focused on empirical research articles pub- lished between 2002 and 2014 and categorised them into five main domains: performance, contract, risk, value for money and institutional issues.

Cui et al. (2018) further carried out a study of the literature dated from 1990 until 2016 and identified six topics. The most prominent was performance management, followed by governance and regulation, economic viability, and value for money. The fourth topic was risk management and success factors, while the fifth was procurement and contract management, and the last was financial packages and PPP ap- plications. The cited authors highlight that the water sector is in the top three focus areas of PPP studies. Cui et al. (2018) research included 754 peer-reviewed studies from 6 continents and 56 different countries and regions. These authors observed that 379 studies focused on infra- structure projects. Transport projects was at the top of the list (111 studies), followed by health and hospital (39) and water supply (37).

The present study's results significantly contribute to the above PPP systematic literature reviews by updating the findings on PPP arrangements in the water sector. Water sector PPP projects have been given increasing importance in the literature, and these are among the top five most researched PPP infrastructure schemes (Cui et al., 2018). Accord- ing to Global Water Intelligence (2016), the worldwide water market, which includes industrial water and wastewater, was estimated to be worth US$174 billion in 2016, with an expected annual growth of 3.8% up to 2020. Water sector PPP contracts have also been used in different geographical and institutional contexts, and developed and developing countries (Jensen, 2017).

The current research also contributes to the literature from a methodological perspective as compared to previous studies. The systematic review design protocol adopted was based on a hybrid method combining systematic quantitative, semantic network and narrative analyses, and the main research

themes were identified with lexical analysis tools. All studies until the end of 2018 were taken into account. The initial search identified a total of 315 studies. Of these, 122 studies were found to be connected directly to the main topic: PPP arrange- ments in the water sector. A visual examination of these publications failed to uncover any previous systematic literature reviews exclusively dedicated to water sector PPP projects, further re-enforcing this research's value.

Satisfying populations' basic water needs and improving their quality of life is on policymakers' agenda both in developed and developing countries. Inadequate water services can generate: economic (e.g., slower economic development), social (e.g., illness, morbidity and premature mortality) and environmental (e.g., pollution) costs (Torta- jada, 2014). The water sector has applied the PPP model most frequently in developing countries lacking adequate infrastructure (Ameyaw and Chan, 2016). Researchers have suggested that this sector's use of PPP contracts has produced advantages, such as reduced operating costs, increased work productivity, and improved quality of life for residents (Ameyaw and Chan, 2015b; Davis, 2005).

The current study's purpose was to provide a comprehensive, holistic review of PPP arrangements research in water sector journals, starting with the first article on this topic published in 1992. This study also sought to conduct a review of PPP arrangements related to the water sector to identify the main insights offered by the relevant literature. More specifically, the present research focused on answering these questions:

1. What have been the primary contributions of different countries or regions and researchers to the study of water sector PPP projects?
2. What have been the primary research designs used to study these projects?
3. What themes and insights i.e., does this literature offer regarding water sector PPP arrangements?
4. What still needs to be investigated?

We address these questions with a hybrid methodology including systematic quantitative review methods and semantic network and narrative analyses (Jin and

Wang, 2014).

This paper is structured as follows. The next section presents the research methodology. Section three offers the results and describes the findings produced by systematic, semantic and narrative analyses. The final section details the conclusions and indicates paths for future research, as well as this study's limitations.

2. Research methodology

We identify relevant studies of PPP strategies in the water sector by adopting Yu et al. (2018) approach to planning, designing and con- ducting searches (see Fig. 1). The first phase included organising and formulating the literature review protocol. The review was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Protocols (PRISMA-P, 2015) guidelines (Gualandi et al., 2019; Moher et al., 2016; Sarsam et al., 2020). The initial 17-item checklist proposed by PRISMA-P 2015 was adapted to address the present study's research questions.

Scopus was selected as the primary search engine among available options (e.g., Google Scholar, Web of Science, PsycARTICLES, PsycINFO, SAGE Premier, PubMed, and B-on). Scopus has been suc- cessfully used in similar studies (e.g., Bao et al., 2018; Cui et al., 2018; Osei-Kyei and Chan, 2015; Yi and Chan, 2014), and this database more effectively provides access to the literature on management, business and accounting (Tober, 2011).

In the second phase, the keywords related to the topic under study were identified. The words selected were categorised into nine different groups that considered the water sector as part of the broader utilities sector and includes other related subsector activities, such as waste- water management (Asian Development Bank [ADB], 2009; Marin, 2009). As time restrictions were not applied, all the studies published until the end of 2018 were taken into account. The search strategy re- sults are shown in Table 1. The initial search retrieved 315 studies (see the full search codes in the appendix).

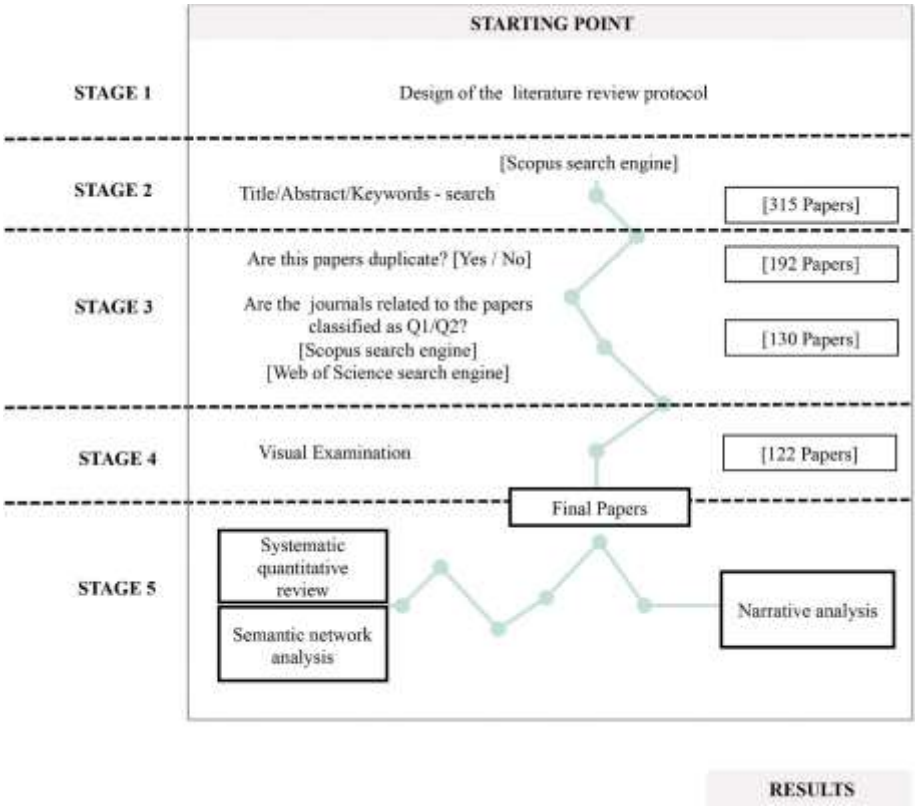


Fig. 1. Research framework based on titles, abstracts, and keywords.

After identifying and retaining the unique results, the total number of studies was reduced to 192. The target journals were selected based on the following criteria: journals and books listed in the SCImago Journal Rank Indicator and Web of Science database for 2017. The journals are ranked by the average number of citations received by documents published over the previous three years. Based on this criterion, the number of studies that fulfilled the prerequisites was reduced to 130. The next step was a visual examination to assess the publications' scientific value and relevance to research on PPP arrangements in

the water sector. A total of 8 studies were excluded from the sample, resulting in a final corpus of 122 studies from 74 journals.

The research methods used had a hybrid design, including systematic quantitative review methods and semantic network and narrative analyses (Jin and Wang, 2014). The systematic quantitative review determined the studies' geographical distribution; date of publication; number of publications by journal, authors, and

institutions; and methodologies. Power Business Intelligence (BI) software tools were used to facilitate the data analysis of the sample documents based on geographical distribution by region since Power BI has been successfully used in previous studies (Krishnan et al., 2017).

The present research generated a word cloud based on the keywords' frequency (Cui et al., 2018) using the Power BI Word Cloud tool. The semantic network analysis was first conducted using Leximancer software, after which Word Cloud explored the connections among the topics that corroborated the narrative analysis of the publications reviewed (Jin and Wang, 2014). Leximancer extracted qualitative data from the semantic network detected, using keywords from 122 selected studies. This software functioned as a conceptual and relational analysis tool, producing a co-occurrence matrix based on keyword frequency.

Leximancer established these words' rate of incidence and then identified the connections between the words and major topics (Lupu et al., 2018). Triangulation was achieved by combining visual observations, identified themes and connected concepts, thereby supporting the narrative analysis discussed in section three.

3. Results

3.1. Systematic quantitative review

3.1.1. Publications' distribution by regions and time

The number of studies of water sector PPP projects published in top journals has increased in recent years. The research published from 2010 to 2018 includes 86 (70%) of the articles analysed. The next most prolific period was from 2000 to 2010, which covered 30 (25%) documents in the sample, followed by 1990–2000 with 6 (5%) studies (see Fig. 2).

The research reviewed shows variations between developed and developing countries in PPP implementation models. The latter nations need to invest heavily in infrastructure (e.g., water supply, roads, bridges, railways and seaports), which has contributed to increased use of the PPP business model. PPP contracts in developing countries offer opportunities to access capital, utilise innovative techniques and take advantage of expertise and know-how (Siemiatycki, 2013;

Willoughby, 2013). When categorised by region, the greatest number of studies fall within Asia, followed by Europe and Africa, in the three periods

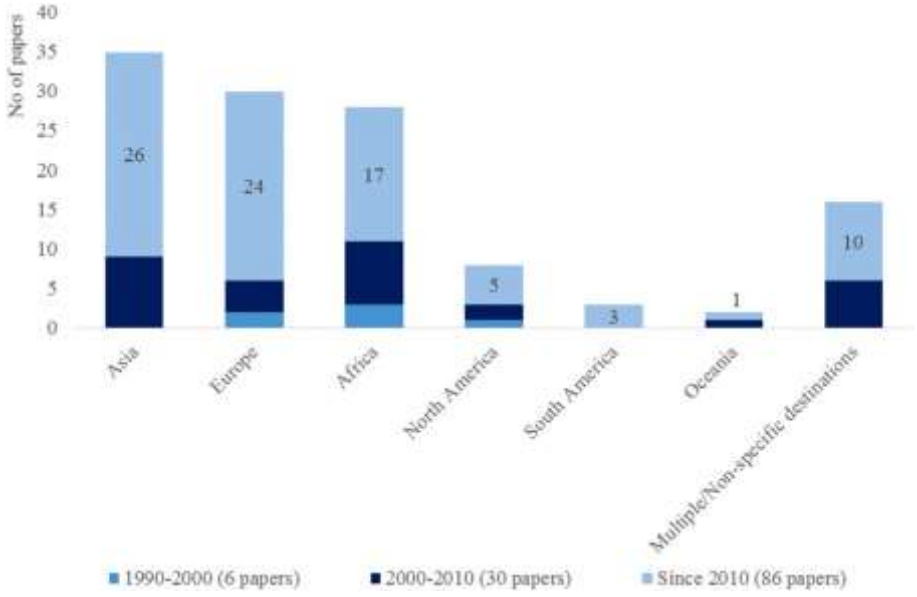


Fig. 2. Publications distributed by region and year of publication.

considered. This pattern is especially true of 2010–2018, followed by 2000–2010 and 1990–2000 (see Fig. 2 above).

3.1.2. Number of publications by journal, author and institution

The 122 studies reviewed were published in 74 journals. The leading journals in the publication of PPP research on the water sector are the International Journal of Water Resources Development, Public Works Management and Policy and Utilities Policy (see Table 2). The most productive authors are A. P. C. Chan with ten studies, followed by E. E. Ameyaw with seven and R. C. Marques with 6 (see Table 3).

Table 4 presents the data on the most productive institutions. The Hong Kong Polytechnic University leads with 20 publications, followed by the Technical University of Lisbon (currently renamed as University of Lisbon) with 11 publications and Cornell University and the University of Science and Technology Beijing, with six publications each. Combining the institutions and countries, China comes first with 30 studies, followed by Portugal with 11 studies and the

US with ten studies (see Table 4).

3.1.3. *Geographical distribution of studies*

Of the initial 122 studies, 83% focused on PPP projects in 45 countries. The results are presented as a heat map, a graphical representation of sample frequency and geographical distribution.

3.1.4. *L*eading institutions with the most publications.

Table 2
Leading journals.

Journal	Number of Studies
International Journal of Water Resources Development	10
Public Works Management and Policy	6
Utilities Policy	6
Local Government Studies	4
Water S.A.	4
Journal of Facilities Management	4
Water Resources Management	4
Public Administration	3
Water Policy	3
Journal of Construction Engineering and Management	3
Others	27
Total Number of Journals out of 122 Studies	**74**

PPP arrangements in the water sector are registered in the World Bank Public-Private Infrastructure Advisory Facility's Private Partici-pation in Infrastructure Project Database (see ppi.worldbank.org). Between 1995 and 2018, 60 countries and 1028 PPP projects were identified in the water sector, representing an investment of US$67 billion. According to the cited source, identifying the amount invested was impossible for 24% of the PPP projects.
The results presented in Fig. 3 above are not entirely aligned with the frequency of the PPP projects registered in the above database. For example, the Word Bank ranks East Asian and Pacific countries first with 587 projects and US$28 billion in investments, and China leads those

Fig. 3. Sample's frequency and geographical distribution.

countries with 510 PPP projects valued at US$16 billion. According to Fig. 3 above, the area showing the highest frequency of projects studied is Europe; Central Asia appears in third place with 64 projects and US$5 billion in investments. The Russian Federation ranks first in the latter group with 27 projects worth US$3 billion.

The results show that developing regions can be worthwhile areas for productive future research on PPP water contracts. These contracts facilitate higher levels of private investment in water infrastructure, thereby contributing to the relevant populations' increased wellbeing. These benefits can have a significant impact on developing countries.

3.1.4. Study methodologies

The reviewed research's methodology includes qualitative, used by 54 (44%) studies (e.g., Cruz and Marques, 2012; Gopakumar, 2014); quantitative, by 42 (34%) (e.g., Owen, 2016; Vedachalam et al., 2016); and mixed methods, by 26 (21%) (e.g., Breytenbach & Manning, 1999; Lo¨e & Mitchell, 1993). Table 5 provides an overview of how the different methodologies were applied in the research reviewed.

The research design assessment yielded interesting results. The most frequently applied approach is case studies with 63 examples (e.g. Cruz & Marques, 2013a and 2013b; Williams, 2018), which confirms the tendencies found by previous literature reviews of PPP research (Yu et al., 2018). This design can be a useful tool for researchers seeking to understand detailed data and information about a specific topic (Cav- aye, 1996). Research based on interviews is ranked second, with 26 studies (e.g., Carvalho et al., 2018; Chan & Cheung, 2011) followed by surveys mentioned by 17 publications (e.g., Ameyaw et al., 2017; Wibowo & Mohamed, 2010).

3.2. Development of and connections between key topics: semantic analysis

Word Cloud's frequency analysis function facilitated the research topics' classification based on high-frequency keywords – excluding 'PPP', 'water', 'public-private' and 'partnerships' (see Fig. 4). The most robust word connections suggest that risk management, financial package and governance are popular topics.

Leximancer's results revealed eight themes (see Fig. 5). The highest- ranked concepts are 'public-private' with 65 hits (84%), 'risk' with 19 (25%) and 'public' with 11 (14%), while the remaining themes' hits add up to 14 (0.18%). Visual observations produced similar results. The studies' main domains include PPP projects in 122 studies (100%), risk management in 37 (30%), contractual arrangements in 23 (19%), financing and tariffs in 22 (18%), infrastructure in 16 (13%) and governance in 7 (6%).

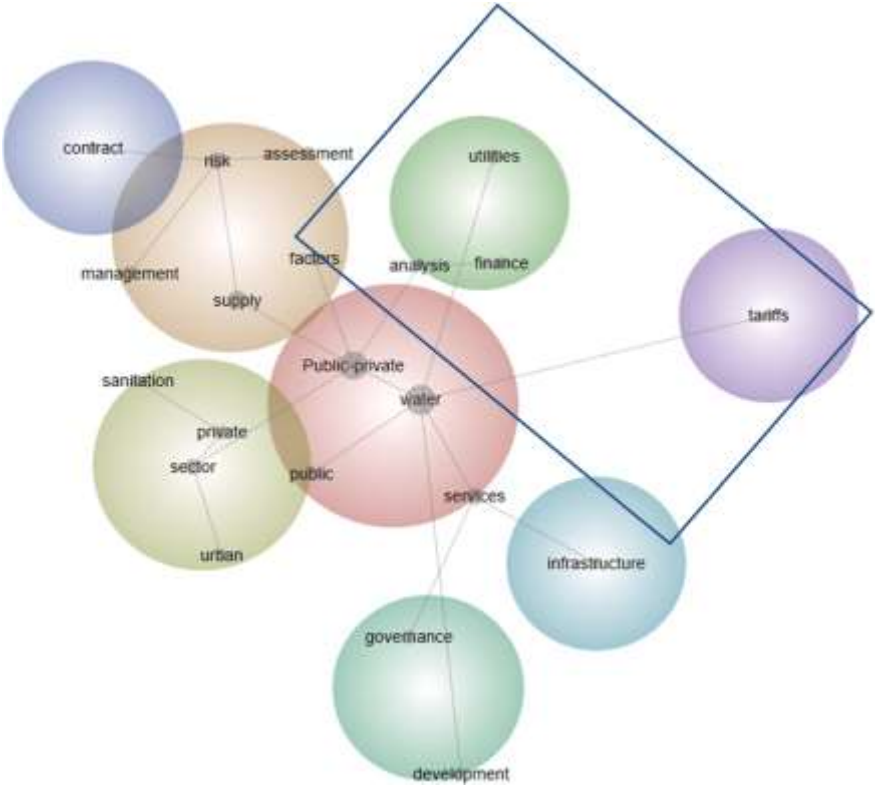
As shown by the main domains, risk management in PPP contracts is a compelling concern. Cui et al. (2018) research also confirmed that this is a hot topic since risk management and success factors were given fourth place, and 18% of studies were related to PPP contractual ar- rangements. Risk management in PPP contracts comprises the process of risk identification, assessment and allocation, as well as management strategies (Cui et al., 2018).

Table 5
Methodologies adopted by studies.

Methodology	Number of Studies	Research Design					
		Descriptive	Content Analysis	Case Study	Longitudinal	Interview	Survey
Qualitative	54	3	8	36	5	14	0
Quantitative	41	2	2	9	2	4	9
Mixed methods	26	1	4	18	2	8	8
Total	**122**	**6**	**14**	**63**	**9**	**26**	**17**

Fig. 4. Word cloud of research topics.

Fig. 5. Concept map of PPP themes by Leximancer.



The public-private theme includes the concepts of water (77, 100%), public (11, 14%) and services (8, 10%). The theme risk management theme covers the concepts of management (11, 14%), supply (11, 14%) factors (6, 08%) and assessment (6, 08%). The theme of contractual arrangements contains a single concept (3, 0.4%). The financing and tariffs themes are closely connected, comprising the concepts of utilities (9, 12%) and analysis (3, 0.2%). The theme of infrastructure contains a single concept (20, 26%), and the final theme of governance includes the concept of development (4, 5%).

3.3. Narrative analysis

Water sector PPP arrangements are a focus of all the selected studies (i.e., 122 publications). Because the results obtained in this particular case were connected to the search engine criteria and thus were highly biased, this theme was removed from the list of emerging themes. However, a clearer understanding of the water sector is needed before these themes can be discussed. This subsection, therefore, first briefly describes PPP contracts, including their key characteristics.

The water sector is traditionally characterised by vertical and horizontal fragmentation and intense exposure to political and institutional factors (Asian Development Bank, 2009).This sector is also highly vulnerable to various economic externalities, climate change and calamities and factors affecting the stability of the country which can in- fluence costs of service not directly transferable to customer tariffs (Ameyaw and Chan, 2013).

The water sector's projects require intensive capital investments and entail substantial sunk costs. Most assets are underground, and they are expected to last 30–50 years, with depreciation rates of 3–5% annually. The payback period is 15–30 years with low return rates (Marques, 2018). The sector must continuously pay special attention to asset management since assets are expected to have a long life cycle, and asymmetrical information is available regarding their state of preservation in both privately and publicly run projects (Grimsey & Lewis, 2002a, 2002b). Most assets cannot be easily evaluated by private operators due to

administrative or regulatory constraints, so the opportu- nities to perform adequate assessments before rebuilding or operating assets are limited (Ameyaw and Chan, 2013).

Water company privatisation in the United Kingdom (Chong et al., 2006) has helped to strengthen PPP projects' dissemination across the water sector as a business model. This trend reflects the influence of the bilateral and multilateral financial institutions involved (Zhong et al., 2008). The key reason for the United Kingdom's water privatisation was to limit the government intervention needed, including reducing investment and allowing the private sector to operate and finance the sector directly (Lobina and Hall, 2001). During the 1990s, many experts believed that the private sector could efficiently deliver sustainable growth in the electricity and water sectors.

However, subsequent evidence has shown that this policy has limitations and that boundaries must be created to ensure the concept of private initiative is applied effectively (Lobina and Hall, 2004). The privatisation approach was adapted to fit the utility services context, thus becoming the total or partial transfer of a company's managerial control from the public to the private sector. The process comprises arrangements ranging from management contracts to concessions transforming the privatised company into a profit-seeking business (Lobina, 2005). PPP water contracts are generally medium or long term (Grimsey & Lewis, 2002a, 2002b).

Given the above findings, a further review of the literature is needed to identify the various vectors that can foster good or bad relationships during contract life cycles. Conflicts will sometimes arise because public partners are inadequately prepared for projects or fail to develop an effective monitoring plan (Guasch et al., 2014). Incomplete contracts; an inadequate internalisation of structural, social and economic changes; and information asymmetries between partners can mean that terms need to be renegotiated (Cruz and Marques, 2013a, 2013b; Marques, 2018).

Idelovitch and Ringskog (1995) argue that this type of strategic alliance can help partners overcome obstacles such as poor performance and productivity in the water sector, especially in a developing country context. Marin (2009) further

proposed four broad categories of factors that can influence performance levels: access to water and wastewater services, quality of service, operational efficiency and impacts on tariffs. Regardless of the contract model chosen, the primary purpose of PPPs is to transfer the responsibility for infrastructure's assessment, design, construction or maintenance and to share the risks associated with system operations (Ameyaw and Chan, 2013).

3.3.1. *Theme one: risk management*

Risk management in the water sector is a focus in 37 studies (30%). As mentioned previously, risk management in PPP contracts is a compelling concern in the field. Cui et al. (2018) research also provided evidence that this theme is a central topic in PPP studies, with risk-management and success factors ranked fourth and included in 18% of articles' main domains.

The first step in defining appropriate project risk management is to develop appropriate risk management strategies. This process comprises two key phases: 1) a risk assessment that includes risk identification, analysis and evaluation and 2) the implementation of risk treatment and management strategies that include quantification of impacts and minimisation measures (Ameyaw and Chan, 2015a; Cui et al., 2018; Inter- national Standards Organisation [ISO], 2018a). Risk can be estimated as

the likelihood of a particular event occurring multiplied by the corresponding impacts' quantification (Marques and Berg, 2011a; 2011b). Risk identification is associated with systematic observations conducted to classify specific projects' potential risks. The risk-assessment phase involves evaluation of how the identified risks can affect projects' success and expected outcomes (Ameyaw and Chan, 2015c).

Risk allocation is also crucial for researchers seeking to understand to what extent each partner (i.e., private or public) is responsible for addressing the identified risks (i.e., the risk owner) (Ameyaw & Chan, 2013, 2015a, 2015c, 2016; Wibowo

and Mohamed, 2010). Unbalanced risk allocation can be mentioned in legal disputes between partners. For example, in 2010, the municipality of Barcelos in Portugal contested Águas de Barcelos's (AdB) demands for renegotiated contract terms, which were presented to the court of arbitration, by arguing that the contract could be considered null and void because AdB did not take on any risk (Marques, 2018).

According to the water-sector literature, the most significant risk factors are insufficient water tariffs, water pricing uncertainty, financing, tax policy changes, interest rates and volatility and unstable water resource prices. Other factors are government instability and breach of contract, national financial institutions' weakness and public opinion resistance (Ameyaw and Chan, 2015c). Risk factors can easily be affected by external forces, such as social and cultural diversity or pro- jects' location in developed or developing regions (Ameyaw and Chan, 2016; Ameyaw et al., 2017).

Grouping risk factors into categories can help distinguish these variables. For instance, Unkovski and Pienaar (2009) proposed that risks can be categorised as financial, legal, and technical. The process of ranking risk factors highlights another significant category: critical risk factors (Ameyaw et al., 2017). Risk evaluation and ranking have attracted more scholars' attention in recent years (Ameyaw & Chan, 2015a, 2015c, 2016; Ameyaw et al., 2017; Pradhan et al., 2017).

Given the water sector's characteristics, risk factor rankings cannot be generalised to all projects' settings (Ameyaw and Chan, 2015c). Nonetheless, critical risk factors have been ranked by researchers in all 37 studies connected to risk management in PPP water contracts. Consequently, the results do not show any consensus due to projects' diversity, type and external environments, among other direct or indirect factors.

The most frequently mentioned risks (Ameyaw and Chan, 2013; (Asian Development Bank, 2009); Marin, 2009) are economic exter- nalities, political and institutional factors including governments' breach of contract and interference, natural disasters such as climate changes and calamities, financing, including

capital investments, water pricing uncertainty, water tariffs, water resources, price instability and poor performance and productivity.

Current risk management practices, especially in the water sector, can be strengthened by using tools already found useful in similar sectors. Marques (2016) conducted a study of PPP arrangements in the Brazilian sector, concluding that most risks will be retained by the public sector if the risk matrix is unbalanced. Despite the conceptual limita- tions of risk matrixes (e.g., providing an assessment only when contracts are formed), their use has shown that they can improve contracts' chances of being based on accurate information (Mahamid, 2011).

3.3.2. Theme two: PPP contractual arrangements

The theme of PPP contractual arrangements focused on 23 studies (19%). According to Yescombe (2007), PPP contracts are one possible type of long-term strategic alliance between two partners. The options available depend on the type of assets involved, namely, greenfield projects for new assets or brownfield projects for significant infrastructure removal. Options also vary according to business partners' shared level of responsibility. That is, private partners can experience a significant increase in their responsibilities in contracts, including the design, construction, rehabilitation, financing, maintenance and oper- ation of public facilities' infrastructure. The available options also depend on how private partners are to be paid: totally via service users' fees or via public partners – or a combination of both sources (Guerrini and Romano, 2017; WorldBank, 2017).

In a closer look at the water sector literature various options regarding contractual arrangements involving water services providers are found (Guerrini and Romano, 2017; Reynaud, 2015). First, service contracts assign a lower level of shared responsibility to providers. In this option, a company owned or controlled by the government (i.e., the public party) decides to outsource a segment of its business based on the existing infrastructure to a private company (i.e., the private party). Services can be provided using exclusively internal resources (i.e., operation and maintenance contracts), and the public partner pays the private partner.

Second, some contracts require a higher level of involvement be- tween public and private partners who implicitly share responsibilities such as management

decisions about operations and maintenance of infrastructure in order to provide an adequate level of service. These contracts ask private companies to manage and maintain significant components of water services. According to the World Bank (2017), two major types of contracts currently exist. The first is concessions in which users pay the PPP projects' parties, and the new or existing infrastruc- ture requires the transference of functions that include design, construction, financing, operation, and maintenance. The private partner provides services directly to the users who are entirely or partially responsible for payment. The second type of contract is when some partnerships require a higher level of involvement between public and private partners who implicitly share responsibilities (e.g., management decisions about operations and infrastructure maintenance) to provide adequate service levels. These contracts expect private companies to own, manage and maintain significant components of water services.

PPP contracts are generally medium or long term, so researchers have closely examined the various variables that can generate good or bad relationships during contracts' life cycle. Conflicts can arise when public partners fail to prepare adequately for projects, design contracts badly and neglect to develop effective monitoring plans (Ameyaw and Chan, 2015c; Guasch et al., 2014). Incomplete contractual arrangements and insufficient capacity for internalising structural, social and eco- nomic changes can also combine with information asymmetries between partners to force them to renegotiate contracts' terms ((Cruz and Marques, 2013a); (Cruz and Marques, 2013b); Marques, 2018). The theory of incomplete contracts can provide a different approach to re- negotiations so that contract revisions may involve updating terms because new information arises that was unavailable when the initial contractual terms were written (Grossman and Hart, 1986).

3.3.3. Theme three: financing and tariffs

The theme of financing and tariffs in the water sector is present in 22 studies (18%). This topic can be separated into two different perspectives. The first focuses on how PPP contracts can be crucial to attracting investment that will develop the necessary infrastructure and provide the public with services. The second perspective is related to how contracts' public partners ensure private

payments are made (i.e., user fees, payment by public partners or both).

Large scale infrastructure investment tends to present challenges. Investors are strongly influenced by various internal and external factors that can individually or together influence decisions about financing water infrastructure, which is a relevant cause for concern (Marques and Berg, 2011a, 2011b). Regional or country development level can be decisive regarding its access to credit and long-term international loans provided by local and national banks (Yu et al., 2018). Financing problems can be related to the macroeconomic environment, financial systems' instability and local or national banks' weak institutional ca- pacity, all of which can determine financing's accessibility and avail- ability and thus influence projects' attractiveness (Chou and Pramudawardhani, 2015). Water supply projects tend to be capital intensive, and additional effort may be needed to secure an adequate level of financing to ensure that projects are sustainable in the medium or long term.

Various options are available in terms of the method chosen to secure private partners' payment for providing services to users. The necessary funds can come entirely from users' fees, be provided only by public partners or combine these two options (World Bank, 2017). In this context, the system selected for setting water tariffs is of particular importance.

For example, in 2011, the Italian national water authority observed a paradigm shift in the revenue-cap regulatory scheme. The first type was called 'metodo tariffario normalizzato', which changed to the 'metodo tariffario transitorio' from 2012 to 2013, to the 'metodo tariffario idrico' (MTI) from 2014 to 2015 and, finally, to the MTI2 from 2016 to 2019. According to Guerrini and Romano (2017), the MTI tariff system was designed to transfer costs to users based on the principles of 'full cost recovery' and 'the polluter pays'. Italy's tariff system currently recognises the need to include financing and investment costs, including interest and taxes; recovery operations; and maintenance costs and to make any necessary adjustments based on the previous year's tariffs.

3.3.4. Theme four: infrastructure

The theme of water sector infrastructure is present in 16 studies (13%). Facilities' lack of infrastructure, inadequate design and man- agement and low maintenance levels compromises their capacity to deliver universal coverage through water networks (Tortajada, 2014). This sector is thus characterised by a need for extensive investment in projects and infrastructure construction and maintenance (An et al., 2018).

Topics such as a lack or excess of infrastructure capacity are common issues in the water sector that significantly impact business activities during PPP water contract life cycles. Construction time and cost over- runs are among the most critical risks in water-related PPP arrangements (Ameyaw and Chan, 2015c; Shen et al., 2006). Overall, water infra- structure is complex to design, build and maintain. Problems range from a lack of adequate projects to weak institutional support in the sector, inconsistency in approved investment plans and a lack of coordination between construction firms (Ameyaw and Chan, 2015c).

The ISO's (2018b) ISO/cd 55011.2 was developed in response to the issues connected to asset management, and guidelines for public policymakers are also being prepared. This useful tool helps national governments achieve a balance between investing in new infrastructure (i. e., greenfield projects) or choosing to repair and replace existing assets (i.e., brownfields projects). The ISO/55002's principles include planning company asset management, executing asset management objectives and risk management, monitoring operations, analysing asset management systems and making decisions based on continuous improvement (ISO, 2018a; 2018b; 2018c).

3.3.5. *Theme five: governance*

The theme of water sector governance appears in seven studies (6%) and focuses on project governance in connection with government policymakers' interference in PPP water contracts. Researchers regularly observe that projects reveal a mismatch between the governance approaches applied and the real reasons why projects are developed (Cui et al., 2018). When institutions' governance practices fail to match – and facilitate integration into – national water sector policies and local contexts, problems can arise connected to a lack of transparency, engagement and accountability (Beisheim and Campe, 2012).

Some of the controversy surrounding PPP water contracts' institu- tional design is due to water's conceptualisation in specific national policies. Water is sometimes seen as a collective or economic good, especially in developing countries that choose private partners con- nected to non-profit organisations (Wibowo and Mohamed, 2010). In addition to depending on sector-specific policies, water services can often be considered a national priority and, thus, more focused on obtaining access and adequate service levels for all segments of the population – including ensuring water quality standards. This perspective may mean that the sector is forced to neglect water systems' economic sustainability. Evidence has been found that an adequate regulatory framework and strategic approach can help mitigate these issues (Abednego and Ogunlana, 2006).

Finally, PPP governance performance can be compromised by instability in the ways tariff systems are defined, a lack of opportunities for private infrastructure ownership and misguidance due to inadequate governmental regulations (Mouraviev and Kakabadse, 2015). To solve these problems, national and local institutions must apply clearly defined strategic approaches to the water sector to ensure stability and attract and retain private partners.

4. Conclusions and directions for future research

The present study conducted a detailed review of research on PPP contracts connected to the water sector in order to identify the field's tendencies. This

research included applying a hybrid method that

combined a systematic quantitative review with both semantic and narrative analyses to highlight the results (i.e., themes) presented in the articles reviewed. The findings provide answers to the research ques-

tions identified in this paper's introduction. The four main research questions and related insights are discussed below.

The first question focuses on the primary contributions of different countries or regions and researchers to the study of water sector PPP arrangements. The number of studies related to PPP projects in the water sector has increased, especially over the last decade, as this theme was identified in 86 (70%) of the total sample of 122 publications. The most productive institutions are situated in Asia with 26 (21%), followed by Europe with 24 (20%) and Africa with 17 (14%). The results proved to be quite similar in terms of the distribution of the authors and countries

or regions included in the present study's sample.

The second question focuses on the predominant research designs used to study these PPP contracts. The publications in question are not concentrated in specific journals and instead are distributed across 74 journals. Regarding the research designs used, the findings include an absence of any clear tendency regarding which methodologies are chosen, namely, 54 qualitative (44%), 42 quantitative (34%) and 26 mixed methods (21%) studies.

The third question is as follows: What insights (i.e., themes) does this literature offer regarding water sector PPP arrangements? The five themes identified during the semantic analysis that were not included in the initial keywords search were risk management, PPP contractual arrangements, financing and tariffs, infrastructure and governance. The theme of risk management is the most prominent with 37 studies (30%). This theme had already been identified in previous studies on PPP projects (e.g., Cui et al., 2018; Ke et al., 2009), and it includes subtopics such as risk assessment, identification and factors, as well as how to choose the best model to ensure adequate analyses, evaluations and risk treatment measures (Ameyaw and Chan, 2015a; Cui et al., 2018; ISO, 2018a).

The second most important theme is PPP contractual arrangements, in which poor design and the multiple possibilities often present can lead to future problems between PPP partners and the need to renego- tiate the terms that regulate partnerships. The financing and tariffs theme comes in third place with 22 studies (18%). This area includes the need to improve contracts to attract the necessary investment to develop infrastructure, including finding a balance between financial and eco- nomic sustainability, which will ensure that payments are made (i.e.,

user fees and public partners' payments or both). This flexibility respects the water sector's specific social and economic characteristics.

The theme of water sector infrastructure was found in 16 studies (13%). As mentioned previously, the sector typically requires extensive investment in infrastructure construction, rehabilitation and mainte- nance since poor project design and a lack of suitability and institutional support can compromise partnerships' success. Public partners' lack of – or inadequate – governance structure was the final theme identified in seven studies (6%). Researchers have observed that government poli- cymakers' interference in PPP water contracts can lead to a mismatch between the projects' initial purpose and their final design (Beisheim and Campe, 2012; Cui et al., 2018).

The fourth research question asks: What still needs to be investi- gated? The corresponding findings provide the basis for recommenda- tions for future research on the five identified themes. Regarding the theme of risk management, various research streams that address this topic were identified, but the present review did not find a consensus about which risk matrix can best be used to support PPP contracts, especially in the water sector. Marques (2016) confirmed that an un- balanced risk matrix could result in allocating most risks to the public sector. The present analysis of previous studies clearly showed that the tools needed to perform risk evaluation and allocation deserve further research with reference to water- related PPP arrangements. Thus, risk matrixes that can be used to improve water PPP contracts should be further investigated to provide firm guidelines for public entities dealing with risk management to improve PPP contract design and risk allocation.

Unbalanced risk allocation between public and private partners emerges as a crucial issue in terms of ensuring partnership stability (Ameyaw & Chan, 2013, 2015a, 2015c, 2016; Wibowo and Mohamed, 2010). Marques (2018) confirmed that these weaknesses could fuel legal disputes when contract terms are renegotiated. Ameyaw and Chan (2015b) successfully used a fuzzy logic technique to define adequate levels of risk allocation for decision-makers, but the cited authors acknowledged that their method has limitations and that further work is needed in this area to develop a computerised system.

An analysis of the theme of PPP contractual arrangements revealed room for improvement in PPP contract renegotiation approaches (e.g., Cruz and Marques, 2013a; 2013b; Guerrini and Romano, 2017) as they need to be revised to meet both private and public partners' expecta- tions. Studies focused on this topic would especially benefit from casestudies and qualitative research design.

Regarding the theme of financing and tariffs, unbalanced PPP project financing is reflected in PPP arrangements' limited ability to attract investors who can provide funding for the necessary water infrastructure. This problem is a hot topic for further studies, namely, trans- parency measures that governments should adopt to ensure adequate financing levels. While Guerrini and Romano (2017) provide an over- view of different methods used to define tariffs in Italy, more research is required on how to ensure that private partners receive payment for providing services to users. Future studies should also concentrate on adapting the solutions identified to fit the contexts of developed and developing economies.

Water projects are associated with extensive investment in infra- structure construction (An et al., 2018). Project management tools need to be developed to cope with the inefficient construction and cost con- trol practices identified by Ameyaw and Chan (2015c) and Shen et al. (2006). Researchers could also design appropriate monitoring measures to ensure an adequate level of infrastructure knowledge.

Regarding the theme of PPP governance structure and institutional support, some subtopics emerged as requiring a significant amount of further research. For example, studies of how regulation by contract and PPP units can be set up would

be a positive step towards designing and supporting implementation, knowledge internalisation and the spread of best practices (Marques, 2018 and Neto et al., 2020). Water sector PPP projects evidently have much room for improvement so researchers could take a closer look at these entities' composition, role and internal organisation. Finally, the policy impacts of different national PPP regulatory frameworks also deserve more research.

The present study has some limitations. Although the results cover all the studies published until the end of 2018, the sample was restricted to published articles listed by the Scopus search engine and published in top journals, as well as the nine keyword combinations used (see the appendix). Moreover, the themes covered in this paper are identified for the water sector. Due to the systematic literature review methodological approach, other topics that might be prominent in the PPP research are not meaningful for our search regarding the number of studies found specifically for the water sector as it is the case of the principal-agent theory (see Smith et al., 2018; Shrestha et al., 2019), regulation and contractual/management issues (Stern, 2012; Marques, 2017), or competition and market power (Mols, 2010; Pu et al., 2020), which might have been highlighted by our research. Future research could thus benefit from choosing different combinations of keywords and widening the search to other search engines.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

1. TITLE-ABS-KEY ("public-private partnerships") AND TITLE-ABS- KEY ("wastewater") AND TITLE-ABS-KEY ("contracts") AND LIMIT-TO (DOCTYPE, "ar") AND LIMIT-TO (SUBJAREA, "ENVI") OR LIMIT-TO (SUBJAREA, "ENGI") OR LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "ENER") OR LIMIT-TO (SUBJAREA, "BUSI") AND LIMIT-TO (LANGUAGE, "English") AND LIMIT-TO (SRCTYPE, "j")
2. TITLE-ABS-KEY ("public-private partnerships") AND TITLE-ABS- KEY ("wastewater")

AND TITLE-ABS-KEY (“utilities”) AND LIMIT- TO (SUBJAREA, “ENVI”) OR LIMIT-TO (SUBJAREA, “ENGI”) OR LIMIT-TO (SUBJAREA, “BUSI”) OR LIMIT-TO (SUBJAREA, “ENER”) OR LIMIT-TO (SUBJAREA, “SOCI”) AND LIMIT-TO (DOCTYPE, “ar”) AND LIMIT-TO (LANGUAGE, “English”) AND LIMIT-TO (SRCTYPE, “j”)

3. TITLE-ABS-KEY (“public-private partnerships”) AND TITLE-ABS- KEY (“wastewater”) AND TITLE-ABS-KEY (“infrastructure”) AND LIMIT-TO (SUBJAREA, “ENVI”) OR LIMIT-TO (SUBJAREA, “ENGI”) OR LIMIT-TO (SUBJAREA, “SOCI”) OR LIMIT-TO (SUBJAREA, “BUSI”) OR LIMIT-TO (SUBJAREA, “ECON”) AND LIMIT-TO (DOCTYPE, “ar”) AND LIMIT-TO (LANGUAGE, “English”) AND LIMIT-TO (SRCTYPE, “j”)
4. TITLE-ABS-KEY (“public-private partnerships”) AND TITLE-ABS- KEY (“sanitation”) AND TITLE-ABS-KEY (“contracts) AND LIMIT- TO (SUBJAREA, “SOCI”) OR LIMIT-TO (SUBJAREA, “ENVI”) OR LIMIT-TO (SUBJAREA, “BUSI”) OR LIMIT-TO (SUBJAREA, “ENGI”) AND LIMIT-TO (DOCTYPE, “ar”) AND LIMIT-TO (LANGUAGE, “English”) AND LIMIT-TO (SRCTYPE, “j”)

5. TITLE-ABS-KEY (“public-private partnerships”) AND TITLE-ABS- KEY (“sanitation”) AND TITLE-ABS-KEY (“utilities”) AND LIMIT- TO (DOCTYPE, “ar”) AND LIMIT-TO (SUBJAREA, “ENVI”) OR LIMIT-TO (SUBJAREA, “SOCI”) OR LIMIT-TO (SUBJAREA, “BUSI”) OR LIMIT-TO (SUBJAREA, “ENGI”) OR LIMIT-TO (SUBJAREA, “ENER”) AND LIMIT-TO (LANGUAGE, “English”) AND LIMIT-TO (SRCTYPE, “j”)
6. TITLE-ABS-KEY (“public-private partnerships”) AND TITLE-ABS- KEY (“sanitation”) AND TITLE-ABS-KEY (“infrastructure”) AND LIMIT-TO (DOCTYPE, “ar”) AND LIMIT-TO (SUBJAREA, “SOCI”) OR LIMIT-TO (SUBJAREA, “ENVI”) OR LIMIT-TO (SUBJAREA, “ENGI”) OR LIMIT-TO (SUBJAREA, “BUSI”) OR LIMIT-TO (SUBJAREA, “ENER”) AND LIMIT-TO (LANGUAGE, “English”) OR LIMIT-TO (LANGUAGE, “Spanish”) AND LIMIT-TO (SRCTYPE, “j”)
7. TITLE-ABS-KEY (“public private partnerships”) AND TITLE-ABS-KEY (“contracts”) AND TITLE-ABS-KEY (“water”) AND LIMIT-TO (SUB- JAREA, “ENVI”) OR LIMIT-TO (SUBJAREA, “SOCI”) OR LIMIT-TO (SUBJAREA, “ENGI”) OR LIMIT-TO (SUBJAREA, “BUSI”) OR LIMIT-TO (SUBJAREA, “ECON”) OR LIMIT-TO (SUBJAREA, “ENER”) AND LIMIT-TO (DOCTYPE, “ar”) AND LIMIT-TO (LANGUAGE, “English”) OR LIMIT-TO (LANGUAGE, “Spanish”) AND LIMIT-TO (SRCTYPE, “j”)
8. TITLE-ABS-KEY (“public private partnerships”) AND TITLE-ABS-KEY (“utilities”) AND TITLE-ABS-KEY (“water”) AND LIMIT-TO (SUB- JAREA, “ENVI”) OR LIMIT-TO (SUBJAREA, “SOCI”) OR LIMIT-TO (SUBJAREA, “ENGI”) OR LIMIT-TO (SUBJAREA, “BUSI”) OR LIMIT-TO (SUBJAREA, “ENER”) OR LIMIT-TO (SUBJAREA, “ECON”) AND LIMIT-TO (DOCTYPE, “ar”) AND LIMIT-TO (LANGUAGE, “English”) OR LIMIT-TO (LANGUAGE, “French”) AND LIMIT-TO (SRCTYPE, “j”)
9. TITLE-ABS-KEY (“public private partnerships”) AND TITLE-ABS-KEY (“infrastructure”) AND TITLE-ABS-KEY (“water”) AND LIMIT-TO (DOCTYPE, “ar”) AND LIMIT-TO (LANGUAGE, “English”) OR LIMIT-TO (LANGUAGE, “French”) OR LIMIT-TO (LANGUAGE, “Spanish”) AND LIMIT-TO (SRCTYPE, “j”) AND LIMIT-TO (SUB- JAREA, “ENVI”) OR LIMIT-TO (SUBJAREA, “SOCI”) OR LIMIT-TO (SUBJAREA, “BUSI”) OR LIMIT-TO (SUBJAREA, “ENGI”) OR LIMIT-TO (SUBJAREA, “ECON”) OR LIMIT-TO (SUBJAREA, “ENER”)

References

Abednego, M., Ogunlana, S., 2006. Good project governance for proper risk allocation in public-private partnerships in Indonesia. Int. J. Proj. Manag. 24, 622–634. https:// doi.org/10.1016/j.ijproman.2006.07.010.

Ameyaw, E., Chan, A., 2013. Identifying public-private partnership (PPP) risks in managing water supply projects in Ghana. J. Facil. Manag. 11 (2), 152–182. https:// doi.org/10.1108/14725961311314651.

Ameyaw, E., Chan, A., 2015a. Evaluating key risk factors for PPP water projects in Ghana: a Delphi study. J. Facil. Manag. 13 (2), 133–155. https://doi.org/10.1108/ JFM-10-2013-0051.

Ameyaw, E., Chan, A., 2015b. Risk allocation in public-private partnership water supply projects in Ghana. Construct. Manag. Econ. 33 (3), 187–208. https://doi.org/ 10.1080/01446193.2015.1031148.

Ameyaw, E., Chan, A., 2015c. Risk ranking and analysis in PPP water supply infrastructure projects: an international survey of industry experts. Facilities 33 (7/ 8), 428–453. https://doi.org/10.1108/EL-01-2014-0022.

Ameyaw, E., Chan, A., 2016. A fuzzy approach for the allocation of risks in public-private partnership water-infrastructure projects in developing countries. J. Infrastruct. Syst. 17 (March), 395–408. https://doi.org/10.1061/(ASCE)IS.

Ameyaw, E., Chan, A., Owusu-Manu, G., 2017. A survey of critical success factors for attracting private sector participation in water supply projects in developing countries. J. Facil. Manag. 15 (1), 35–61. https://doi.org/10.1108/JFM-06-2016-0027.

An, X., Li, H., Wang, L., Wang, Z., Ding, J., Cao, Y., 2018. Compensation mechanism for urban water environment treatment PPP project in China. J. Clean. Prod. 201, 246–253. https://doi.org/10.1016/j.jclepro.2018.08.003.

Andon, P., 2012. Accounting-related research in PPPs/PFIs: present contributions and future opportunities. Accounting. Auditing & Accountability Journal 25 (5), 876–924. https://doi.org/10.1108/09513571211234286.

Asian Development Bank, 2009. Asian Development Bank Guidance Note: Urban Water Supply Sector Risk Assessment.

Bao, F., Chan, A., Chen, C., Darko, A., 2018. Review of public-private partnership literature from a project lifecycle perspective. J. Infrastruct. Syst. 24 (3), 04018008 https://doi.org/10.1061/(ASCE)IS.1943-555X.0000424.

Beisheim, M., Campe, S., 2012. Transnational public-private partnerships' performance in water governance: institutional design matters. Environ. Plann. C Govern. Pol. 30 (4), 627–642. https://doi.org/10.1068/c1194.

Breytenbach, K., Manning, C., 1999. Financing municipal BOOTs in South

Africa: the lenders' perspective. Dev. South Afr. 16 (4), 707–728. https://doi.org/10.1080/03768359908440109.

Carvalho, B., Marques, R., Netto, O., 2018. Regulatory impact assessment (RIA): an ex- post analysis of water services by the legal review in Portugal. Water Resour. Manag. 32 (2), 675–699. https://doi.org/10.1007/s11269-017-1833-0.

Cavaye, A., 1996. Case study research: a multi-faceted research approach for IS. Inf. Syst. J. 6 (3), 227–242. https://doi.org/10.1111/j.1365-2575.1996.tb00015.x.

Chan, A., Cheung, E., 2011. Risk factors of public-private partnership projects in China: comparison between the water, power, and transportation sectors. J. Urban Plann. Dev. 137 (4), 409–415. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000086.

Chen, Z., Daito, N., Gifford, J., 2016. Data review of transportation infrastructure publicprivate partnership: a meta-analysis. Transport Rev. 36 (2), 228–250. https://doi. org/10.1080/01441647.2015.1076535.

Chong, E., Huet, F., Saussier, S., Steiner, F., 2006. Public-private partnerships and prices: evidence from water distribution in France. Rev. Ind. Organ. 29 (1), 149–169.

Chou, J., Pramudawardhani, D., 2015. Cross-country comparisons of key drivers, critical success factors and risk allocation for public-private partnership projects. Int. J. Proj. Manag. 33 (5), 1136–1150. https://doi.org/10.1016/j.ijproman.2014.12.003.

Cruz, N., Marques, R., 2012. Mixed companies and local governance: No man can serve two masters. Publ. Adm. 90 (3), 737–758. https://doi.org/10.1111/j.1467-9299.2011.02020.x.

Cruz, C., Marques, R., 2013a. Endogenous determinants for renegotiating concessions: evidence from local infrastructure. Local Govern. Stud. 39 (3), 352–374. https://doi. org/10.1080/03003930.2113.783476.

Cruz, C, Marques, R, 2013b. Exogenous determinants for renegotiating public

infrastructure concessions: evidence from Portugal. J. Construct. Eng. Manag. 139 (9), 1082–1090. https://doi.org/10.1061/%28ASCE%29CO.1943-7862.0000710.

Cui, C., Liu, Y., Hope, A., Wang, J., 2018. Review of studies on the public-private partnerships (PPP) for infrastructure projects. Int. J. Proj. Manag. 36 (5), 773–794. https://doi.org/10.1016/j.ijproman.2018.03.004.

Davis, J., 2005. Private-sector participation in the water and sanitation sector. Annu. Rev. Environ. Resour. 30 (1), 145–183. https://doi.org/10.1146/annurev. energy.30.050504.144635.

Fang, S., Liu, L., Bao, J., Fang, W., 2009. The research on multi-task bundling of public- private partnerships based on principal-agent model. In: 2009 International

Conference on Information Management, Innovation Management and Industrial Engineering. IEEE Computer Society Digital Library, pp. 384–388. https://doi.org/ 10.1109/ICIII.2009.100.

Fernandez, R.N., Saulo, H., Carraro, A., Tourrucoˆo, F., Hillbrecht, R., 2018. Public- private partnership contractual design: a computational model of the moral hazard with lotteries. Publ. Organ. Rev. 18 (1), 39–51. https://doi.org/10.1007/s11115- 016-0359-x.

Global Water Intelligence, 2016. Global Water Market 2017, vol. 1.

Gopakumar, G., 2014. Experiments and counter-experiments in the urban laboratory of water-supply partnerships in India. Int. J. Urban Reg. Res. 38 (2), 393–412. https:// doi.org/10.1111/1468-2427.12076.

Grimsey, D., Lewis, M., 2002a. Evaluating the risks of public private partnerships for infrastructure projects. Int. J. Proj. Manag. 20 (2), 107–118. https://doi.org/ 10.1016/S0263-7863(00)00040-5.

Grimsey, D., Lewis, M.K., 2002b. Evaluating the risks of public private partnerships for infrastructure projects. Int. J. Proj. Manag. 20 (2), 107–118. https://doi.org/ 10.1016/S0263-7863(00)00040-5.

Grossman, S., Hart, O., 1986. The costs and benefits of ownership: a theory of vertical and lateral integration. J. Polit. Econ. 94 (4), 691–719. https://doi.org/10.1086/ 261404.

Gualandi, R., Masella, C., Tartaglini, D., 2019. Improving hospital patient flow: a systematic review. Bus. Process Manag. J. 26 (6), 1541–1575. https://doi.org/ 10.1108/BPMJ-10-2017-0265.

Guasch, J., Benitez, D., Portabales, I., Flor, L., 2014. The renegotiation of PPP contracts:

an overview of its recent evolution in Latin America. In: OECD Discussion Paper 2014–18, October. https://doi.org/10.1787/5jrw2xxlks8v-en.

Guerrini, A., Romano, G., 2017. Contract renegotiation by an Italian wastewater utility: action research to promote effective tariff revision. Util. Pol. 48, 176–183. https:// doi.org/10.1016/J.JUP.2017.08.004.

Hajjej, I., Hillairet, C., Mnif, M., Pontier, M., 2017. Optimal contract with moral hazard for public private partnerships. Stochastics 89 (6–7), 1015–1038. https://doi.org/ 10.1080/17442508.2017.1303068.

Hart, O., 2017. Incomplete contracts and ownership. Am. Econ. Rev. 107 (7), 1731–1752. https://doi.org/10.1257/aer.107.7.1731.

Idelovitch, E., Ringskog, K., 1995. Private-sector Participation in the Water-Supply and Sewerage Sector in Latin America. World Bank Group Library [PDF file]. https://eli brary.worldbank.org/doi/abs/10.1596/0-8213-3219-8.

International Organization for Standardization, 2018a. Asset Management – Management Systems – Guidelines for the Application of ISO 55001 (ISO 55002: 2018). https://www.iso.org/standard/70402.html.

International Organization for Standardization, 2018b. Guidance on the development of government asset management policy (ISO/CD 55011). https://www.iso.org/ standard/72701.html.

International Organization for Standardization, 2018c. Risk Management – Guidelines (ISO 31000:2018), second ed. https://www.iso.org/standard/65694.html.

Jensen, O., 2017. Public–private partnerships for water in Asia: a review of two decades of experience. Int. J. Water Resour. Dev. 33 (1), 4–30. https://doi.org/10.1080/ 07900627.2015.1121136.

Jin, X., Wang, Y., 2014. Chinese outbound tourism research: a review. J. Trav. Res. 55 (4), 440–453. https://doi.org/10.1177/0047287515608504.

JMP, 2020. Global data on water supply, sanitation and hygiene. https://washdata.

org/data.

Ke, Y., Wang, S., Chan, A., Cheung, E., 2009. Research trend of public-private partnership in construction journals. J. Construct. Eng. Manag. 135 (10), 1076–1086. https://doi.org/10.1061/(ASCE)0733-9364(2009)135:10(1076).

Krishnan, V., Bharanidharan, B., Krishnamoorthy, G., 2017. Research Data Analysis with Power BI [Presentation]. 11th International CALIBER-2017 Anna University, Chennai, Tamil Nadu. http://ir.inflibnet.ac.in/handle/1944/2116.

Lobina, E., 2005. Problems with private water concessions: a review of experiences and analysis of dynamics. Int. J. Water Resour. Dev. 21 (1), 55–87. https://doi.org/ 10.1080/0790062042000313304.

Lobina, E., Hall, D., 2001. UK Water Privatisation – A Briefing. Public Services International Research Unit. www.psiru.org.

Lobina, E., Hall, D., 2004. Private and public interests in water and energy. Nat. Resour. Forum 28 (4), 268–277. https://doi.org/10.1111/j.1477-8947.2004.00100.x.

Lo¨e, L., Mitchell, B., 1993. Public-private partnerships: water and wastewater services in

France. Water Int. 18 (3), 137–146. https://doi.org/10.1080/02508069308686170.
Lupu, C., Brochado, A., Stoleriu, O., 2018. Visitor experiences at UNESCO monasteries in

Northeast Romania. J. Herit. Tourism 14 (1), 1–16. https://doi.org/10.1080/1743873X.2018.1506458.

Mahamid, I., 2011. Risk matrix for factors affecting time delay in road construction projects: owners' perspective. Eng. Construct. Architect. Manag. 18 (6), 609–617. https://doi.org/10.1108/09699981111180917.

Marin, P., 2009. Public-private Partnerships for Urban Water Utilities: A Review of Experiences in Developing Countries: No. 8. World Bank.

Marques, R., 2016. PPP arrangements in the Brazilian water sector: a double-edged sword. Water Pol. 18 (2), 463–479. https://doi.org/10.2166/wp.2015.115.

Marques, R., 2017. Why not regulate PPPs? Util. Pol. 48, 141–146. https://doi.org/

10.1016/j.jup.2017.04.003.

Marques, R., 2018. Is arbitration the right way to settle conflicts in PPP arrangements? J. Manag. Eng. 34 (1), 05017007 https://doi.org/10.1061/(ASCE)ME.1943-5479.0000564, 1-7.

Marques, R., 2018. Regulation by contract: overseeing PPPs. Utilities Policy 50, 211–214. https://doi.org/10.1016/j.jup.2017.10.004.

Marques, R., Berg, S., 2011a. Risks, contracts and private sector participation in infrastructure. J. Construct. Eng. Manag. 137 (11), 925–933. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000347.

Marques, R, Berg, S, 2011b. Public-private partnership contracts: A tale of two cities with different contractual arrangements. Public Administration 89 (4), 1585–1603. https://doi.org/10.1111/j.1467-9299.2011.01944.x.

Marsilio, M., Cappellaro, G., Cuccurullo, C., 2011. The intellectual structure of

research into PPPS: a bibliometric analysis. Publ. Manag. Rev. 13 (6), 763–782. https://doi. org/10.1080/14719037.2010.539112.

Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P., Stewart, L.A., Estarli, M., Barrera, E.S.A., Martínez-Rodríguez, R., Baladia, E., Agüero, S.D., Camacho, S., Buhring, K., Herrero-Lo´pez, A., Gil-Gonz´alez, D.M., Altman, D.G., Booth, A., Whitlock, E., 2016. Preferred reporting items for systematic

review and meta-analysis protocols (PRISMA-P) 2015 statement. Rev. Espan˜ola Nutr. Humana Diet´etica 20 (2), 148–160. https://doi.org/10.1186/2046-4053-4-1.

Mols, F., 2010. Harnessing market competition in PPP procurement: the importance of periodically taking a strategic view. Aust. J. Publ. Adm. 69, 229–244. https://doi. org/10.1111/j.1467-8500.2010.00681.x.

Mouraviev, N., Kakabadse, N.K., 2015. Legal and regulatory barriers to effective public- private partnership governance in Kazakhstan. Int. J. Public Sect. Manag. 28 (3), 181–197. https://doi.org/10.1108/IJPSM-09-2014-0116.

Neto, D., Cruz, C., Rodrigues, F., Silva, P., 2016. Bibliometric analysis of PPP and PFI literature: overview of 25 years of research. J. Construct. Eng. Manag. 142 (10), 06016002 https://doi.org/10.1061/(ASCE)CO.1943-7862.0001163.

Neto, D., Cruz, C., Rodrigues, F., Silva, P., 2020. PPP development and governance in Latin America: analysis of Brazilian state PPP units. J. Infrastruct. Syst. 26 (2) https://doi.org/10.1061/(ASCE)IS.1943-555X.0000544.

Osei-Kyei, R., Chan, A., 2015. Review of studies on the critical success factors for public- private partnership (PPP) projects from 1990 to 2013. Int. J. Proj. Manag. 33 (6), 1335–1346. https://doi.org/10.1016/j.ijproman.2015.02.008.

Owen, D., 2016. Public-private partnerships in the water reuse sector: a global assessment. Int. J. Water Resour. Dev. 32 (4), 526–535. https://doi.org/10.1080/07900627.2015.1137211.

Owusu-Manu, D., Edwards, D., Kukah, A., Parn, E., El-Gohary, H., Hosseini, M.,

2018. An empirical examination of moral hazards and adverse selection on PPP projects.

J. Eng. Des. Technol. 16 (6), 910–924. https://doi.org/10.1108/JEDT-01-2018-

0001.

Pradhan, R., Verma, A., Dash, S., Maradana, R., Gaurav, K., 2017. Critical success factors for PPP infrastructure projects in India. J. Chin. Inst. Eng. 40 (5), 485–491. https://
doi.org/10.1080/02533839.2017.1335619doi.org/10.1080/02533839.2017.13356
19.

Pu, W., Xu, F., Chen, R., Marques, R., 2020. PPP project procurement model selection in China: does it matter? Construct. Manag. Econ. 38, 126–139. https://doi.org/ 10.1080/01446193.2019.1596291.

Reynaud, A., 2015. Public-private Partnerships and Their Ownership in the Urban Water Sector. Springer. https://doi.org/10.1007/978-94-017-9801-3_21.

Sarsam, S.M., Al-Samarraie, H., Alzahrani, A.I., Wright, B., 2020. Sarcasm detection using machine learning algorithms in Twitter: a systematic review. Int. J. Mark. Res. 62 (5), 578–598. https://doi.org/10.1177/1470785320921779.

Shen, L., Platten, A., Deng, X., 2006. Role of public private partnerships to manage risks in public sector projects in Hong Kong. Int. J. Proj. Manag. 24, 587–594. https://doi. org/10.1016/j.ijproman.2006.07.006.

Shrestha, A., Tamo˘saitiene˙, J., Martek, I., Hosseini, M., Edwards, D., 2019. A principal- agent theory perspective on PPP risk allocation. Sustainability 11, 6455. https://doi. org/10.3390/su11226455.

Siemiatycki, M., 2013. The global production of transportation public-private partnerships. Int. J. Urban Reg. Res. 37, 1254–1272. https://doi.org/10.1016/J. TRANPOL.2012.06.014.

Smith, E., Umans, T., Thomasson, A., 2018. Stages of PPP and principal–agent

conflicts: the Swedish water and sewerage sector. Publ. Perform. Manag. Rev. 41, 100–129. https://doi.org/10.1080/15309576.2017.1368399.

Stern, J., 2012. The relationship between regulation and contracts in infrastructure industries: regulation as ordered renegotiation. Regulation & Governance 6, 474–498. https://doi.org/10.1111/j.1748-5991.2012.01141.x.

Tober, M., 2011. PubMed, ScienceDirect, Scopus or Google Scholar – which is the best search engine for an effective literature research in laser medicine? Med. Laser Appl. 26 (3), 139–144. https://doi.org/10.1016/J.MLA.2011.05.006.

Tortajada, C., 2014. Water infrastructure as an essential element for human development. Int. J. Water Resour. Dev. 30 (1), 8–19. https://doi.org/10.1080/07900627.2014.888636.

Unkovski, I., Pienaar, E., 2009. Public private partnerships in South Africa: analysis and management of risks [Presentation]. In: Construction and Building Research Conference of the Royal Institute of Chartered Surveyors (CORBRA 2009), Cape Town, South Africa.

Vedachalam, S., Geddes, R., Riha, S., 2016. Public-private partnerships and contract choice in India's water and wastewater sectors. Publ. Works Manag. Pol. 21 (1), 71–96. https://doi.org/10.1177/1087724X15596171.

Vinogradov, D., Shadrina, E., 2018. Public-private partnerships as collaborative projects: testing the theory on cases from EU and Russia. Int. J. Publ. Adm. 41 (5–6), 446–459. https://doi.org/10.1080/01900692.2018.1426012.

Wibowo, A., Mohamed, S., 2010. Risk criticality and allocation in privatised water supply projects in Indonesia. Int. J. Proj. Manag. 28 (5), 504–513. https://doi.org/10.1016/j.ijproman.2009.08.003.

Williams, J., 2018. Assembling the water factory: seawater desalination and the techno- politics of water privatisation in the San Diego-Tijuana metropolitan region.

Geoforum 93 (May), 32–39. https://doi.org/10.1016/j.geoforum.2018.04.022.

Willoughby, C., 2013. How much can public private partnership really do for urban transport in developing countries? Res. Transport. Econ. 40 (1), 34–55. https://doi. org/10.1016/J.RETREC.2012.06.038.

World Bank, 2017. Public-private partnerships: reference guide version 3. https://openk
nowledge.worldbank.org/handle/10986/29052License:CCBY3.0IGO.

Yescombe, E.R.E. (Ed.), 2007. Public-private Partnerships: Principles of Policy and Finance, vol. 1. Elsevier Ltd. https://doi.org/10.1017/CBO9781107415324.004.

Yi, W., Chan, A., 2014. Critical review of labor productivity research in construction journals. J. Manag. Eng. 30 (2), 214–225. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000194.

Yu, Y., Chan, A., Chen, C., Darko, A., 2018. Critical risk factors of transnational public- private partnership projects: literature review. J. Infrastruct. Syst. 24 (1), 04017042 https://doi.org/10.1061/(ASCE)IS.1943-555X.0000405.

Zhong, L., Mol, A., Fu, T., 2008. Public-private partnerships in China's urban water sector. Environ. Manag. 41 (6), 863–877. https://doi.org/10.1007/s00267-008-9070-1.