

# Mapping Studies on Sustainability in the Performance Measurement of Public-Private Partnership Projects: A Systematic Review

Isaac Akomea-Frimpong <sup>\*</sup>, Xiaohua Jin  and Robert Osei-Kyei

School of Engineering, Design and Built Environment, Western Sydney University, Sydney, NSW 2747, Australia; xiaohua.jin@westernsydney.edu.au (X.J.); r.osei-kyei@westernsydney.edu.au (R.O.-K.)

\* Correspondence: 19624802@student.westernsydney.edu.au

**Abstract:** The integration of sustainable practices into infrastructure projects under the auspices of public-private partnerships (PPPs) is vital in the attainment of United Nation's Sustainable Development Goals (SDGs). Since the inception of the SDGs in 2015, the attention of world has been shifting towards more sustainable practices and it is essential that the conventional performance measurement models on PPP projects also adapt to the trend of sustainable practices. Therefore, This study aims at reviewing and operationalising sustainable performance measures for the PPP infrastructure projects. A systematic literature review (SLR) methodology was utilised in this study. The research process began with the search, retrieval and selection of thirty-three (33) journal articles. Thoroughly, the selected articles were contently analysed to form key themes that form the basis of this research's findings. The outcomes of this review demonstrate twenty-seven (27) most critical sustainable performance criteria of PPP projects such as the lowest project costs, green index, disability-friendly inclusion rate and carbon emission per project among others. Although, the study is limited to few journal articles, it provides theoretical and practical understanding of integration of sustainability in PPPs. Further, it gives a list of relevant research gaps for further studies. This study contributes to the benchmarking and management of sustainable performance assessment of PPP projects.

**Keywords:** sustainability; public-private partnerships; systematic review; performance criteria



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## 1. Introduction

Historically, the partnership between the state and the private sector in the delivery of infrastructure projects can be traced back as early as 1600s [1,2]. Evidence suggests that in 1800s, the United Kingdom (UK), United States (US) and France governments delivered turnpikes and water facilities with the financial support of the private sector [3,4]. Fast-forward to the 1990s, the public sector received a massive boost in private funding of mega infrastructure projects when United Kingdom government rebranded and reintroduced this aged-old model in the built environment and termed it as Public Finance Initiative (PFI). PFI is the precursor of Public-Private Partnerships (PPPs) [5,6] and the model has received wide recognition in other countries aside the United Kingdom in recent times. Globally, PPPs has aided in the construction of numerous projects such as schools, roads, light rail, hospitals, and shopping centres among others [7]. For instance, data from the European Investment Bank (EIB) has shown that 1765 public-private partnership (PPP) contracts were signed in the European Union (EU) from 1990 to 2016, representing a capital value of almost €356 billion [8]. Further evidence from the World Bank and national data shows the growing implementation of PPP to deliver public infrastructure in developing economies to bridge an infrastructural gap amounting to US\$1–\$1.5 trillion [9,10].

Even though, the aforementioned statistical evidence supports the wide acceptance of PPP arrangements in infrastructure development around the world, there are recent

concerns on its long-term sustainable performance [11,12]. The most prominent concerns include the following. First, unexpected external (macro) occurrences such as COVID-19 recession, 2007–2008 recession and a fallout in the financial markets around the world have adverse effects on the sustainability of PPP projects [13]. Second, existing traditional performance assessment measures of PPP projects that heavily rely on the triangle model of time, cost and quality with little emphasis on the key tenets of sustainability practices [14]. Public policies on sustainability have surged since the implementation of United Nation's Sustainable Development Goals (UN SDGs) from 2015 [15]. UN SDGs demand holistic assessment of activities (including PPP projects) emphasising on social and environmental protection [16]. Nevertheless, the current performance assessment of PPP projects have minimally incorporated sustainable practices. Third, empirical studies on sustainability in PPP performance remain few that needs further investigation and publications. There is inadequate conceptualisation of key elements in integrating sustainability principles into the performance measures of PPP infrastructure in research outlets. Compared to topical issues in the PPP research area such as critical success factors [17], risk management [18] and stakeholder [19], sustainable performance measurement remains less explored. Therefore, this study's twofold objectives are:

1. To review and identify the key sustainable performance measures of PPP projects,
2. To operationalise the findings, present gaps and provide directions for further research.

The results of this literature review present relevant checklists and gaps for further investigations into the sustainability of the performance of PPPs. In addition, the study provides benchmarks appropriate for project teams in operationalisation and design of performance framework to assess the performance of PPP projects. The remaining sections of the study have overview of sustainability in the performance of PPP projects, the systematic literature review methodology, results and discussions. The study concludes with summary of the results, implications and limitations.

## 2. Overview of Sustainability in Public-Private Partnership Projects

Brundtland [20] explains sustainability as actions that create development that satisfies the needs of the current generation with appropriate measures to preserve resources for the unborn generations. Conceptually, this explanation establish two key underlying themes. First, it embodies the sustainable practices that promote the well-being of people and meets the basic needs of present society [21]. Second, sustainable measures that embrace technology, social inclusion and green policies to preserve and advance environmental resources for the future [22]. The concept of sustainability has been popularized and the volume of research on it has astronomically increased since the inception of the United Nation's Sustainable Development Goals (SDGs) in 2015 [23]. The PPP research domain is not exception to the sources of the research outputs springing up. Studies on PPP projects such as Liang and Wang [12] emphasized that the relationship between PPP arrangements and sustainability is attained in the integration of efficiency, technological innovation and social dynamics into the projects. Apart of this, PPPs ensure the achievement of economic development of society and financiers by creating jobs as the project's lifecycle create an avenue for involvement of stakeholders [24]. PPPs also broaden the opportunities for economic exchanges via the products or services to widen the revenue net and satisfaction of public goods and services. PPPs promote measures that keep the environment and reduce carbon emissions [25]. How PPPs could be a tool to attain sustainable success in the lifecycle of projects remain an important issue [26].

Sustainability of project's success are realized across the lifecycle of the projects. [27] opined that the success of PPP projects remains important in the global assessment of environmental conditions for infrastructure development. Available metrics to measure environmental-friendly infrastructures under the PPP arrangements include BREEAM (Building Research Establishment Environmental Assessment Method), Green Mark, and green certifications and benchmarks from individual countries [12,27]. Although, the foundational tenets of sustainability are social, economic, and environmental factors, little

research within the PPP research area provides an integrative review and operationalisation into the key sustainable performance measures.

### 3. Research Method

In this study, the research method adopted to search, select and analyse literature to meet the current study's objectives is systematic literature review (SLR). This method, SLR has been used for similar previous studies in the PPP research domain to assess relevant topics such as critical success factors [17], healthcare [28] and financial risk management [29], among others. In Figure 1, the details of the SLR include:

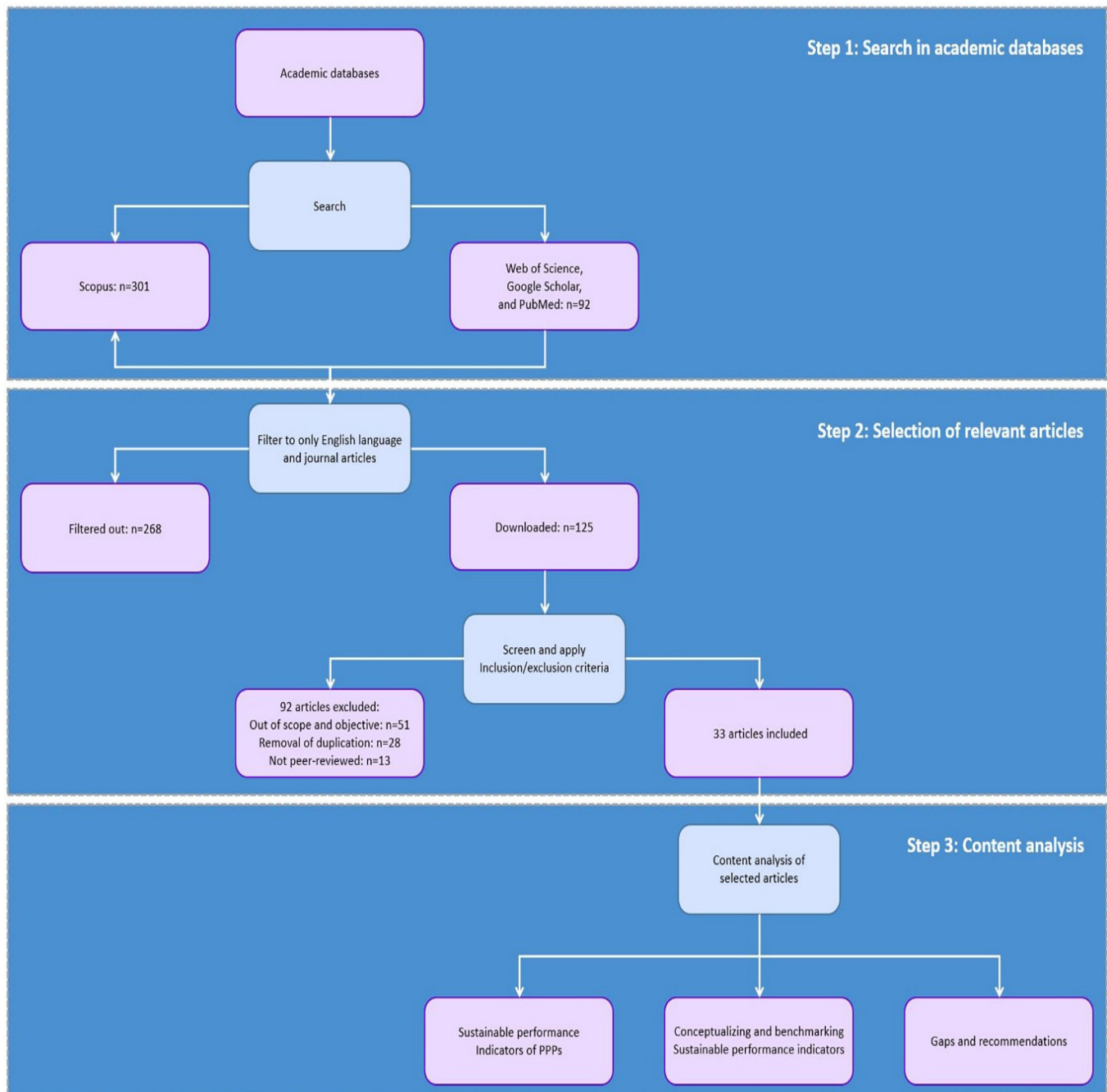


Figure 1. Overall research method map.

### 3.1. Step 1: Search in Academic Databases

The selection of the most appropriate academic databases (search engines) to search for literature was the first priority. In this study, Scopus and Web of Science (WoS) were chosen as the relevant academic databases where studies on sustainable performance measures of PPP projects due to the following reasons. First, the two databases have many scholarly literature serving as a suitable secondary data for academic research [30]. Second, Scopus and WoS have searchable features that make it easy to filter and download literature for systematic literature review [31]. Once the Scopus and WoS have been selected, relevant keywords were identified and keyed into the two search engines. The sustainable performance indicators had keywords such as “sustainable performance” or “sustainable performance indicators”, “sustainability performance criteria”, “environmental, social and governance criteria”, “sustainable performance measures” whiles the public-private partnerships had keywords of “public-private partnership”, “ppp infrastructure projects”, “public-private partnerships”, “Build-Operate-Transfer”, and “Private Finance Initiative”.

The preliminary search results produced 393 documents: 301 from Scopus and 92 from Web of Science. Additionally, the initial results automatically showed the search period from 2003 to 2021. To retrieve the targeted documents, the preliminary outcome was restricted to journal (source type), articles (document type) and English (language). Spontaneously, these restrictions removed 268 documents out of the 393 documents [32,33]. The details of the remaining 125 documents (articles) were retrieved into an excel spreadsheets for further analysis.

### 3.2. Step 2: Selection of Relevant Articles

The inclusion and exclusion assessment of the 125 was undertaken to select the relevant articles. Three criteria set for this study. (i) Removal of duplicate articles. The duplicate analysis revealed 28 articles that appeared twice in both Scopus and WoS excel files [34]. These duplicates were taken out of the 134 reducing the articles to 97 articles. (ii) Deletion of 51 articles that covered little of this study’s objectives. Articles that were out of scope and objectives of this study with just a mention of a keyword [35]. (iii) Exclusion of 13 articles that were poorly reviewed which were either published in conferences or unranked open access journals [36]. To ensure that all other academic databases are exhausted, additional searches took place in Google Scholar and PubMed but no relevant article was identified. Thus, the final number of articles agreed to be suitable for this study was 33 articles in the light of previous studies that used fewer articles [37–39].

### 3.3. Step 3: Content Analysis

In this last stage of the review, the 33 articles were thoroughly examined and compared within the patterns of the research outcomes. Relevant words, statements and keywords were retrieved from the examination of the content of the articles [40]. The extracted items were coded and the common coding patterns were grouped into themes. The themes were subjected to both qualitative interpretations and quantitative scoring and formulation of metrics to ascertain the sustainable performance indicators. Section 4 presents results of all the analysis.

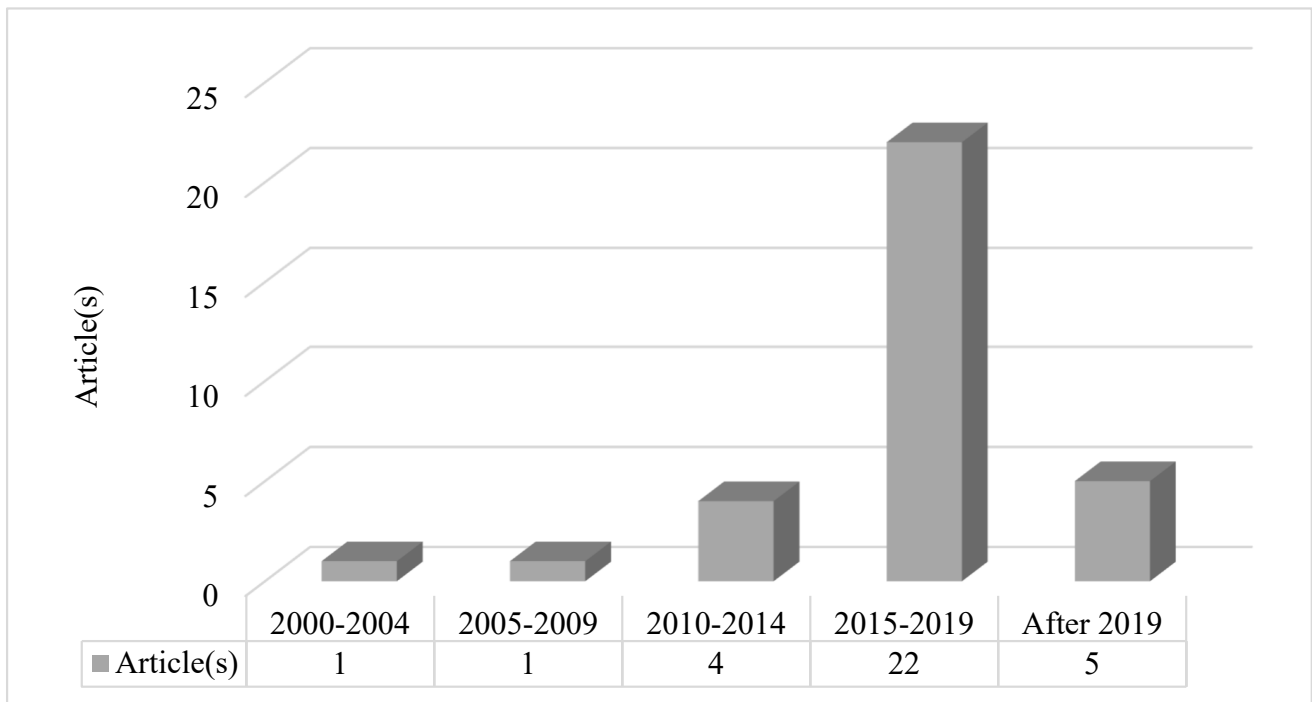
## 4. Results and Discussions

### 4.1. Overview of Selected Articles

#### 4.1.1. Growth in Publication of Articles

There is a surge in publications on the sustainability of performance of PPP projects [41]. Figure 2 demonstrates the annual increment in research outcomes dedicated to establishing the sustainable performance measures of PPP from 2003 to 2021. Publications jumped from one in 2000–2004 and 2005–2009 to four articles in 2010–2014. Exponentially, the articles increased from four articles in the 2010–2014 period to 22 articles in 2015–2019 period. This shows an increment of 275 percent in the publications, a period in which the United Nation’s Sustainable Development Goals (SDGs) came into effect [23]. Since the SDGs

became a prominent policy standpoint around the world, the interests of practitioners, principal partners and researchers in ensuring sustainable performance of PPP projects has increased. Thus, the results underscore the heightened interests to assess and report the sustainable outcomes of PPPs and it is expected that research in this area will grow in future [42].



**Figure 2.** Number of relevant publication(s) from 2003 to 2021.

#### 4.1.2. Distribution of Projects in the Country-of-Origin

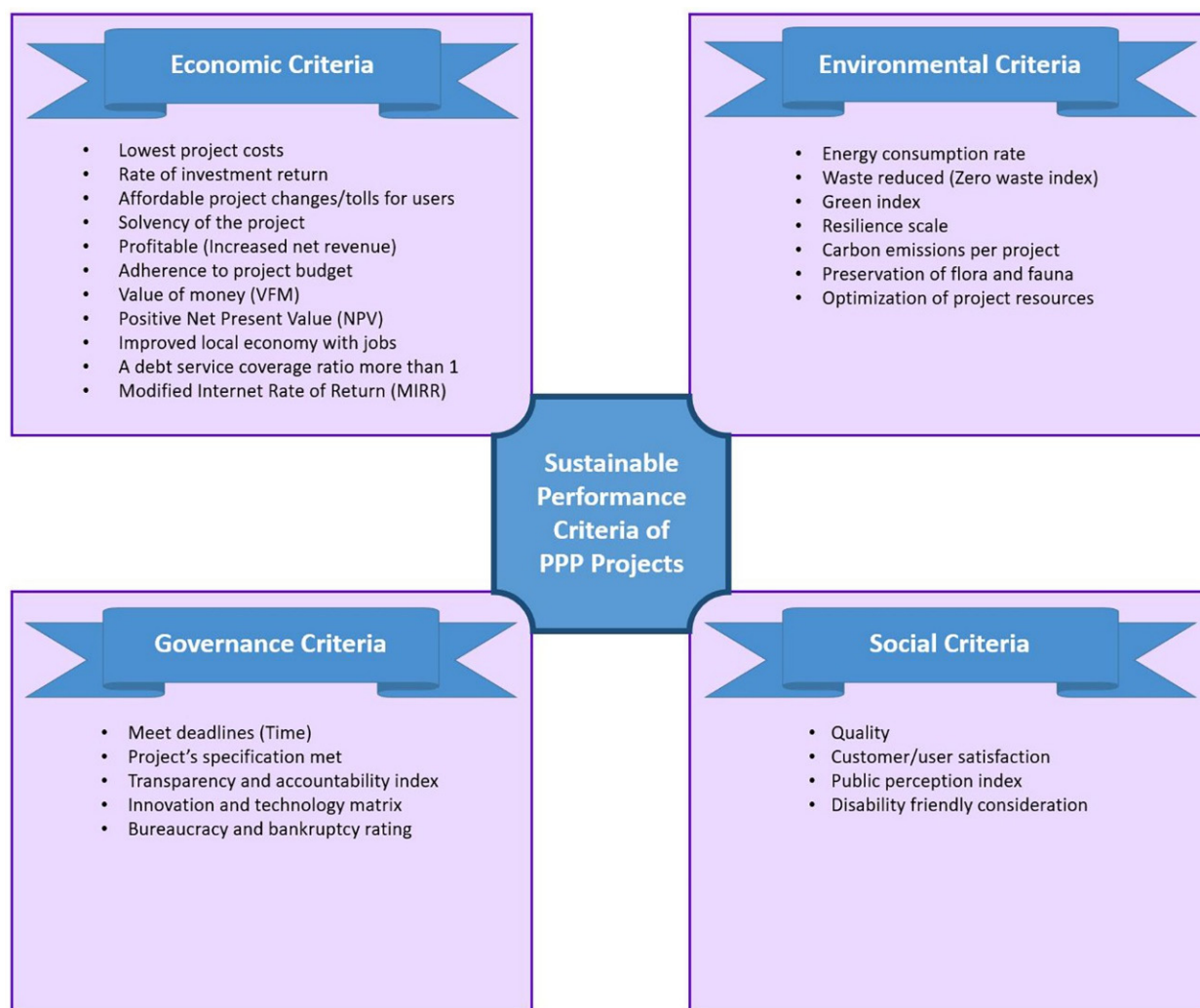
The seventeen (17) countries presented in Table 1 are the countries where leading researches on this topic were undertaken. From Figure 3, most investigations into financial performance of PPP projects took place in Australia, UK and China. Although, PPP projects started early in Europe, the concept has gained more prominence in the construction industry in other parts of the world (especially Asia and Pacific region). The analysis showed that a whopping 61.36 percent of the selected articles came from the countries in this region. Europe (UK, Germany, Italy and Netherlands) came second, recording 11.36 percent of studies. On country-by-country basis, Australia (7 articles) recorded the maximum studies. Australia is ranked as a developed market for PPPs, and the model is promoted by both federal and state governments to deliver public facilities and essential services [43]. Australia is followed by China (5 articles) where the concept of Private Finance Initiative (PFI), the precursor of PPP projects originated from [44] and then UK with 3 articles. PPP projects in Australia and UK have come under intense scrutiny from private investors to ascertain the best sustainable practices to maintain existing projects. Thus, investors demand for sustainable practices in areas of governance, environmental protection and reduction of carbon emissions from the activities of construction [45]. Developing PPP markets such as Ghana, China and Vietnam of PPPs are exposed to greater financial risks affecting the achievement of economic sustainability [31]. In reference to the findings in Table 1, most of the studies reported on general PPP projects or multi-faceted mixture of projects. The generic PPP projects represented 26 of the articles whilst road transport was found to be the second most widely studied sector in PPP in relation to financial performance. For instance, [46] assessed the performance of road toll rates of PPP projects. Hospitals, schools and airport recorded one article each on the performance of PPP projects.



**Table 1.** Matrix of projects and research origins.

Country	Article(s)	Distribution of Project(s)					
		Generic (*)	Roads	Hospital	Airport	Schools	Sports Facility
Australia	7	6	—	—	—	1	—
Multiple nations	6	5	1	—	—	—	—
China	5	4	—	—	—	—	1
UK	3	2	—	—	1	—	—
Hong Kong	2	1	1	—	—	—	—
Ghana	2	2	—	—	—	—	—
Malaysia	2	2	—	—	—	—	—
Italy	1	—	—	1	—	—	—
India	1	1	—	—	—	—	—
Netherlands	1	1	—	—	—	—	—
Bangladesh	1	1	—	—	—	—	—
Vietnam	1	1	—	—	—	—	—
Germany	1	—	1	—	—	—	—
<b>Total</b>	<b>33</b>	<b>26</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>

Note (\*): Generic refers to a mixture of two or more projects in an article.



**Figure 3.** Conceptualizing the review findings.

#### 4.1.3. Dominant Research Techniques

The fundamental research methodologies utilised in the selected studies include surveys, interviews with expert opinions, case studies and key performance indicators, discounted cash flow models such as net present value (NPV) and internal rate of return (IRR). Table 2 shows that survey technique dominated the performance analysis of sustainable performance of PPPs recording 12 articles followed by case studies with seven articles. Telephone and face-to-face interviews were used to obtain relevant information to establish the performance of PPP projects from project managers and all stakeholders related to the projects. Four articles used Value for Money (VfM) as an assessment tool on the sustainable performance of PPPs [47,48]. Two articles used balance scorecard together with Key Performance Indicators (KPIs) to assesses the internal and external view about the performance of PPP projects [49]. Lastly, one articles utilised discounted cash flow techniques to analyse the expected cash flows from lifecycle of the projects.

**Table 2.** Commonly used research techniques in sustainable performance of PPP research.

Technique	Article(s)	Percent (%)
Survey	12	37
Case study	7	21
Interviews	5	15
Value-for-Money (VfM)	4	12
Balanced Scorecard	2	6
Key Performance Indicators (KPIs)	2	6
Discounted Cash flow models (NPV, IRR)	1	3

#### 4.1.4. Citation of Articles

The citation analysis aims to reveal the number of times the 33 articles were cited in other research works. Moreover, the citation of the articles show the impacts the selected publications are contributing to the sustainable performance measurement of PPPs. In addition, where articles are published (journals) have influences on the acceptance of an article among the scientific research community and practices. Thus, Table 3 demonstrates 13 topmost cited articles with at least 50 citations as at the end of 2021 in influential journals. Yuan, et al. [50], Yuan, Wang, Skibniewski and Li [10] and Yuan et al. (2010) [51] drew inferences of key performance indicators to assess the quality and efficiency of sustainable performance of PPPs. These studies were published in highly ranked journals in the construction management field: Journal of Management in Engineering, and Construction Management and Economics. According to Liu, et al. [52], low financial service charges, fixed and low interest rate financing, currency fluctuations and tariffs and toll adjustments on the PPP project are commonly listed as the benchmark to assess the sustainability of PPP projects. It is evident from the results that performance of PPPs are widely ascertained differently. Mladenovic, et al. [49] and Osei-Kyei, et al. [53] mentioned that concession fees and expected environmental costs influence the financial performance of PPPs because it affects the demands of users in perceiving the social and ecological value of the project.

**Table 3.** Ranking of the most cited publications.

No.	Article	Source (Journal)	Impact Score as at 2021	
			H-Index of Journal	Article Citations
1	Yuan, Zeng, Skibniewski and Li [50]	Construction Management and Economics	94	372
2	Yuan, Wang, Skibniewski and Li [10]	Journal of Management in Engineering	70	149
3	Liu, Love, Davis, Smith and Regan [52]	Journal of Infrastructure Systems	67	138

Table 3. Cont.

No.	Article	Source (Journal)	Impact Score as at 2021	
			H-Index of Journal	Article Citations
4	Yuan, et al. [51]	Journal of Management in Engineering	70	129
5	Mladenovic, Vajdic, Wüdsch and Temeljotov-Salaj [49]	Built Environment Project and Asset Management	21	126
6	Osei-Kyei, Chan, Javed and Ameyaw [53]	International Journal of Strategic Property Management	30	114
7	Love, et al. [54]	Automation in Construction	121	114
8	Liyanage and Villalba-Romero [46]	Transport Reviews	82	100
9	Shaoul [55]	Public Money and Management	48	77
10	Koops, et al. [56]	International Journal of Project Management	144	57
11	Osei-Kyei and Chan [57]	Journal of Infrastructure Systems	67	56
12	Liu, et al. [58]	Journal of Management in Engineering	70	54
13	Zhou, et al. [59]	Journal of Financial Management of Property and Construction	22	50

#### 4.2. Critical Sustainable Performance Criteria of PPP Projects

Table 4 demonstrates the dominant performance measures of PPP projects. Drawing lessons from the selected articles, the PPP projects have diverse criteria due to the expectations of stakeholders [60]. The public partner pursues value for money in constructing and managing public facilities [61]. Such a pursuit reduces the expenses taxpayers bear and expenditure within allocated budget [62] and reduce cost overruns. The expectation of the private investor is the maximization of profits and recouping of invested capital from the project [63]. The general public (or users) of the PPP infrastructure demand affordable fees and improvement in economic well-being (in the form of employment and living standards) [10]. Profitability is attained within the lowest project costs and that establishes excess revenue that add to reserve stock of a project. Profit becomes entrenched when there are drastic cost efficiency strategies [64]. Cost efficiency is the reduction of excessive cost overruns of the projects [65]. Cost overruns escalates legal actions, fines and compensations [66,67].

Another indicator of a performing PPP project is the drastic reduction of operational expenditure. Maintenance and operation expenses during the operation of the projects are essential in arriving at the profits that connects to the operations of the project [46]. The extension of the concession period with effective management of maintenance costs and administrative expenses. Additionally, the fluctuations in macroeconomic conditions trigger the performance of PPP projects [68]. Project managers institute hedging mechanisms against these constant changes to protect expected cash inflows [69]. Staying resolute against bankruptcy during economic recessions ensures strong financial support for the project from the start to the decommissioning stage without insolvency [70]. Aside, the insolvency of projects, the principal partners and the project management company also protect the project against bankruptcy of the key financiers that can put the project at risk [71]. In an unlikely event that this occurs, the steering committee of the PPP project together with the enacted laws of the project [72] must analyse and mitigate the severity of the bankruptcy. Bankruptcy is further mitigated by the minimization of financial risks which improves the cash inflows obtained from the project by cutting down the high interest rates and market risks [46]. Deliberate financial control measures must be designed and directed towards reducing the project's financial losses [66]. For example, robust financial risk management techniques such as hedging and minimum guarantee could help address this challenge. Assessment and fair allocation of the financial risks ensuing between the partners [73] reduce the project's specific and systematic financial risks [74,75].



**Table 4.** Sustainable performance measures of PPP projects.

Code	Performance Criteria	References (Citations in the Appendix A)
PEF1	Lowest project costs	[1,2,4,5,7–9,11–20,22–25,27,29–32]
PEF2	Meet deadlines (Time)	[1,2,4–7,10,11,14,16,17,17,18,20–22,26–28,28,30–32]
PEF3	Rate of return of investment	[1–7,9,10,12–15,17,17–21,23,24,32]
PEF4	Project’s specification met	[1,2,4,6–9,11,13,15,17,18,21–27,31,32]
PEF5	Quality score	[1,3,5,7,8,10,12,13,16,17,17,22,25–28,30,32]
PEF6	Customer/user satisfaction	[6–9,12,13,15,17–20,24,26,27,29,30,32]
PEF7	Affordable charges/tolls of projects for users	[1,2,4,6–9,13,15,17,21–23,29,30]
PEF8	Energy consumption rate	[5–9,12,14,15,18,19,22,24,26,32]
PEF9	Solvency of the project	[6–9,13–16,19,24,27,29,30]
PEF10	Public perception index	[5–9,12,14,15,18,19,22,24,26,32]
PEF11	Profitability (increased net revenue)	[1,2,6–9,13,15,18,19,24,27,31]
PEF12	Adherence to project budget	[1,4–9,13,15,17–19,21]
PEF13	Reduction of waste (Zero waste index)	[2,5–8,10,11,15,18,19,21,22]
PEF14	Value-for-money (VFM)	[1,2,10,12,15,17,17,22,27,29,30]
PEF15	Transparency and accountability index	[5–9,15,18,19,32]
PEF16	Positive Net Present value (NPV)	[1,4,5,7,13,15,17,20,32]
PEF17	Improved local economy with jobs	[6–9,15,18–20]
PEF18	Innovation and technology metrics	[6–9,15,24,27,30]
PEF19	Green Index	[6–9,15,18,19,31]
PEF20	Debt service coverage ratio	[1,2,4,5,11,25,30]
PEF21	Modified Internal rate of return (MIRR)	[1,4,11,15,20,32]
PEF22	Resolute against bankruptcy	[2,5,15,17,22,29]
PEF23	Resilience scale	[2,5,27]
PEF24	Carbon emissions per project	[16,27]
PEF25	Disability-friendly	[1,17]
PEF26	Preservation of flora and fauna	[4,31]
PEF27	Optimization of project resources	[20,24]

As a significant financial measure, spending within a PPP project’s budget [76] is essential to contribute to the reduction of unexpected expenses at the construction stage, and minimize the overall lifecycle costs of the project. Although, budget is just one part in the determination of success of a project, a number of failures of PPP projects have been linked to inaccurate estimation and prediction of revenues and costs [26]. Spending within the targeted budget boosts financial interest of investors in similar projects in future. Moreover, adherence to the project’s budget ensures value for money. Value for money to users sustains the long-term financial arrangements between partners. Prior to the awarding of the contract through the lifecycle of the project, financial relationships through negotiations and renewal of contracts are necessary to keep the project on track [77]. Stakeholder’s interests in the project is understood to be collective in nature to prevent the entire stakeholders from pursuing selfish interest of the few, generating chaos and reprisals from opinion leaders and the community [56].

Regular and timely accountability of financial transparency safeguards trade delivery of service to the populace in exchange for extreme and wasteful expenses of project managers [47]. In dealing with the investments from partners, project managers must emphasize the fairness and accuracy of the amount of investments spent [78]. This is a measure of good stewardship of the capital entrusted to them. Project managers and workers refrain from misuse of funds and profligate spending when regular reviews and discussions ensue at the project-level meetings. The steering committee of the project monitor the transparency and timely reportage of the financial activities on the project [79]. The demands of stakeholders (users) of the project are met when the user fees, parking permits and tolls are affordable. Affordability drives people to patronage the project. Potentially, paying less for a good product or service increases the revenues derived from the project [46].

Finally, the project success of the PPPs could be determined by favourability of the social and environmental measures related to capital investment into the project [80]. A net value of the social net and ecological balance is an indication of anticipated stream of achievement within the United Nations Sustainable Development Goals (UN SDGs) [73]. The social and environmental performance constructs of SDGs propels infrastructure projects to align to the United Nations (UN) 2030 Agenda for Sustainable Development [81]. The goal of the SDGs is to include climate change, green principles, and diversity policies in constructing public infrastructures. The 17 SDGs goals promotes sustainable performance and development where each goal is measured accordingly to ensure long-term success [82].

#### 4.3. Conceptual Framework with Operationalisation of Performance Measures of PPPs

The integrated theoretical model in Figure 3 sets the readiness of the assessment of the performance of PPP projects based on established multidimensional theories with operationalisation constructs in Table 5. The proposed conceptualisation of the model has its bedrock in assessment on project dependent on classical theories of market-based view theory, resource-based view theory, strategy-structure theory, triple bottom line and user value-based theory. The underlying constructs of the theories forms the basis of formation of economic, environmental, social and governmental criteria of sustainable performance of PPPs. Based on the market-based view, the external forces of demand and supply in relation to economic conditions and market externalities establish and drive the formation of cash inflow criteria underlying the success of PPP projects [11,83]. Branding and pricing of projects are consistent investments into the investments driven by environmental and macroeconomic factors such as favourable weather conditions and interest rates leading to better outcomes of the project. Yurdakul, Kamaşak and Öztürk [11] revealed the specific macroeconomic-induced criteria of project success with Sharma [84] arguing that the success of public infrastructure projects are not defined only within the context of internal factors of projects. Du, Leten and Vanhaverbeke [83] synchronized the market-based positioning of a project to the attraction of investments for projects. Also, the market positioning and profitability of PPP projects has been widely affected negatively by external factor of Coronavirus pandemic across the world leading to delays in completion of projects and increased financial losses due to prolonged lockdowns and increased health costs [85].

Resource-based view (RBV) theories embrace and use increasingly competitive heterogeneity of outcomes of projects [86]. RBV premises that organisational capabilities of competing interests of resources by diverse stakeholders on the investment returns of the PPP projects differ significantly. based on the premise that close competitors differ in their capabilities and resources [87]. In line with the RBV theory, the commitment of project teams (or project management firms) are demonstrated by the amount of resources and value placed on a project to be innovate and provide the prerequisite financial support to ensure increased cash inflows from the project [46]. The criteria for the performance of PPP projects are heavily influenced by the positive outcomes of economies of scale for investment of the project. The size of the project affects the reduction of costs and increase the financial returns of the projects. RBV proposes the influence of risks in the determination of the profitability of the projects. The internal activities and transactions of the project team and the overall project lifecycle drive the cash outflow [58]. Triple bottom line promotes the reportage of social, environmental and economic factors relating to the project.

Strategy and structure theories establish the defined practical benchmarks for the assessment of the PPP projects influenced by the social processes and policies of project management firms as well as conditions stemming from the industry in which the project is executed [44]. The impact of the firm-specific factors in relation to the project form the basis of the design of the financial outcome benchmarks of the project. Industrial standards are strongly required in the areas of health and cybersecurity as well as sensitivity areas of the economy to execute PPP projects. Slater [88] propounded the value-based theory of the user of a project or product built and released to satisfy the needs of the users of project

covering social and environmental standards. The main intent of the theory is realized when the demands of the project in question are subscribed and provided to cover the financial costs [89]. Attaining better financial outcome for all stakeholders especially the private investors could stimulate and attract huge capital investment to execute similar future projects.

**Table 5.** Operationalisation and measurement benchmarks of performance criteria of PPPs.

Code	Performance Criteria	Operationalisation & Measurement of Variables	References
<b>Environmental criteria:</b>			
PEF8	Energy consumption rate	Energy usage per project. The energy consumption per units of infrastructure or kilometers (roads).	Bakar, et al. [90]
PEF13	Waste reduced (Zero waste index)	The amount of wastes and disposables from the project. The accumulation of wastes in PPP project divided by the total amount of wastes within a project site.	Zaman [91], Lu, et al. [92]
PEF19	Green Index	Projects meets LEED (Leadership in Energy and Environmental Design), Green Building Label (GBL) and all green project certifications.	Heckert and Rosan [93]
PEF23	Resilience scale	Infrastructure is resolute against disasters, floods and force majeure. Measurement and rating on the scale of strongly resilient, resilient, poorly resilient and not resilient.	Ampratwum, et al. [94], Chopra, et al. [95]
PEF24	Carbon emissions per project	The quantum of pollutants released from the project. Total amount of pollution per project.	Huang, et al. [96], Hoeft, et al. [97]
PEF26	Preservation of flora and fauna	Requirements on protecting flora and fauna are met. Adherence to legal regulations on environmental protection.	Widman [98]
PEF27	Optimization of project resources	Efficient usage of resources on a project. Measured in the realization of maximum benefits from resources	Zheng, et al. [99]
<b>Social criteria:</b>			
PEF5	Quality score	Conforming to the construction industry's standards on quality. The yardstick of scale from 0 to 500 based on ISO 9001 standards. 0 to 150 is low quality, 151 to 250 is medium and 251 to 500 is high quality.	Agarchand and Laishram [100]
PEF6	Customer/user satisfaction	Ratings of customer/user satisfaction from 1 to 5. 1 = not satisfied, 2 = low, 3 = neutral, 4 = satisfied, 5 = highly satisfied	Rohman, et al. [101]
PEF10	Public perception index	The perceptions of the public about the outcomes of the project to enrich the cultural and social values of society. An index factor of 0 to 0.25—Poor, 0.26–0.5 it needs improvement, >0.5 acceptable.	Shin, et al. [102]
PEF25	Disability friendly consideration	Accessibility of disable-friendly features to the project such as the usage of wheelchairs. Yes =1 if disable people can access a PPP project, No = 0 if no features are available to assist disable persons.	Goel, et al. [103]

Table 5. Cont.

Code	Performance Criteria	Operationalisation & Measurement of Variables	References
<b>Economic criteria:</b>			
PEF1	Lowest project costs	Minimum recorded costs of the project from the start to the end (lifecycle stages). Measured as “Actual costs project incurred” < “expected project costs budgeted”.	Osei-Kyei and Chan [104]
PEF3	Rate of return of investment	The maximisation of capital investment into the project for key financiers. The calculation is Net profit (revenue) divided by the accumulated capital invested in the project.	Zheng, Xu, He, Fang and Zhang [22]
PEF7	Affordable charges/tolls	Dummy variable, 1= if majority of the users can afford its charges, then it is affordable, 0= if little or users stop using the project because it is unaffordable and expensive.	Liu, et al. [105]
PEF9	Solvency of the project	Ability of project managers to meet all the liabilities of the project both short and long-term. Total liabilities divided by total assets with the acceptance ratio between 0 to 1, but it is problematic if it is more than 1.	Zhang [106]
PEF11	Profitable (increased net revenue)	Optimization of revenues from the project. The measurement is the total accumulated revenue exceeding the total costs.	Engel, Fischer and Galetovic [24]
PEF12	Adherence to project budget	Project finances spent within budget. Excess expenses above budgets are duly justified.	Koops, Bosch-Rekveltdt, Coman, Hertogh and Bakker [56]
PEF14	Value for money (VFM)	Judicious use of resources and project outcomes either meets or exceeds targets in terms of efficiency, economy and effectiveness.	Cheung, et al. [107]
PEF16	Positive Net Present value (NPV)	Maximum net cash flows from a project. Total discounted cash inflows exceeds total discounted cash outflows.	Liyanage and Villalba-Romero [46]
PEF17	Improved local economy with jobs	Creation of jobs and economic growth from the project.	Sharma [84]
PEF20	A debt service coverage ratio	The capacity to pay loan facilities, interests and other related debts of the project promptly. It is calculated as total debts divided by capital invested into the project	Iyer and Balamurugan [61]
PEF21	Modified Internal rate of return (MIRR)	The positive cash flows from a project from a capitalization of the cost of capital or interest rate.	Kurniawan, Mudjanarko and Ogunlana [79]
<b>Governance criteria:</b>			
PEF2	Meet deadlines (Time)	Dummy variable, 1 = if project deadline (schedule date) is met, and 0 = if a project fails to meet a targeted time.	Lin and Lu [108]
PEF4	Project’s specification met	A set of targets on the size, style, functionality and systems of the project. 3 = meet the specifications, 2 = somehow meet the specifications, 1 = poorly meet the specifications, 0 = does not meet the specifications.	Mota and Moreira [109]

Table 5. Cont.

Code	Performance Criteria	Operationalisation & Measurement of Variables	References
PEF15	Transparency and accountability index	Fair and regular reportage of the activities of the project.	Garrido, et al. [110]
PEF18	Innovation and technology Matrix	Attainment of technology and innovation in a project. Dummy, 1 = if technology and innovative services or products have been recorded, 0 = vice versa.	Battisti and Brem [111]
PEF22	Bureaucracy and bankruptcy rating	Rates the bureaucratic processes resulting in corrupt practices and set the project for bankruptcy. 1—0–10 cases are acceptable, 2 = 11–20 case s= manageable, 3 = 21 and above are not acceptable.	Hu, et al. [112]

#### 4.4. Knowledge Gaps and Future Research Agenda

Despite the revealing results obtained from analysing the previous studies about the performance of PPP projects, project managers and researchers must address some limitations in literature (see Figure 4).

1. First, little attention has been focused on climate change policies and climate action in PPP projects. Inadequate available data to assess impacts of fluctuations in climatic conditions on the performance of PPP projects contributes to this phenomenon. Although, there is an increasing demand from policymakers, financiers and users of PPP project managers to take action and include climate change in the design of the performance criteria of PPP projects, minimal studies and project reports mention it [25]. Aside these demands, global pacts on climate change such as 2015 Paris Climate Agreement and 2021 Glasgow COP 26 Agreement urges construction projects to be built in the light of cutting down carbon emissions to zero [113]. However, the management of climate change has not been given the needed attention and support. Therefore, it is a relevant area that industry players and project managers needs to build a holistic database to analyse climate-based performance of PPP projects.

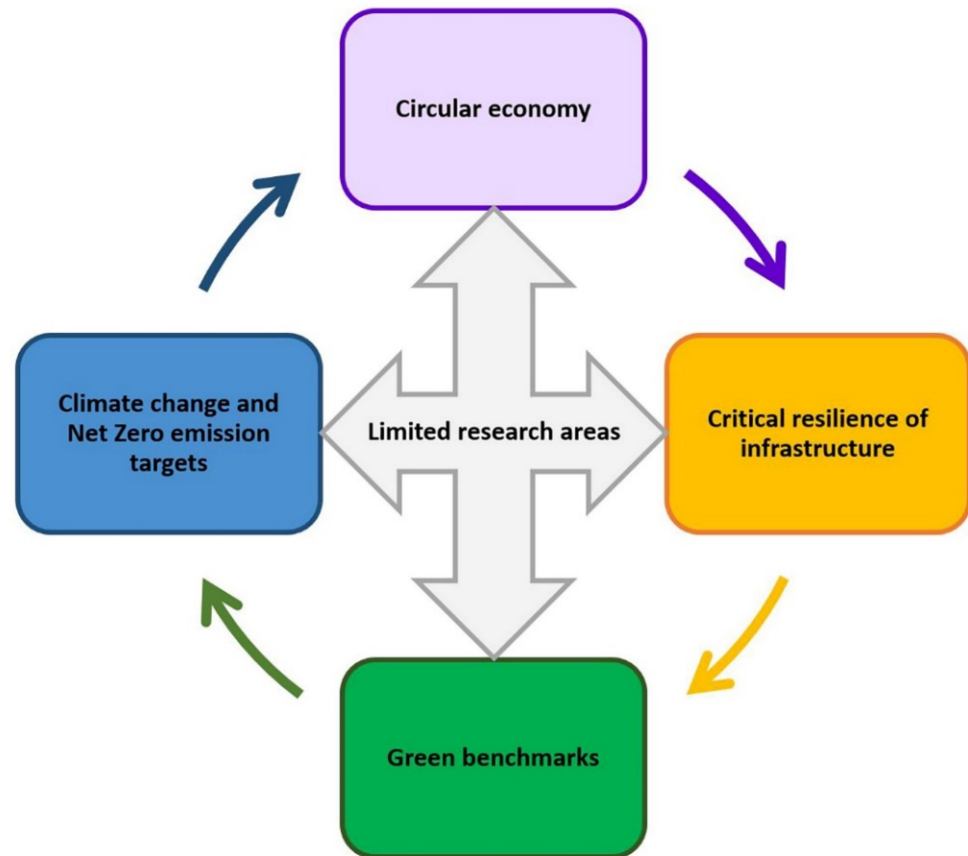
2. The longevity and success of a project is the desire of all stakeholders [114]. However, PPP projects experience setbacks due to unforeseen events such as floods, COVID-19 pandemic and fires that draw back the progress of the project. This has necessitated the inclusion of resilience, diversity and inclusion measures to bulwark the project from attacks and accessible to people with different backgrounds [24,115]. Available project reports suggest that this situation of resilience must be managed properly to propel the performance of the projects but limited research has been conducted on it in the PPP arrangements [94]. Therefore, researchers are encouraged to work with project managers to develop robust models as countermeasure tool to resolve this problem and increase the outcomes of PPPs.

3. Although, some studies exist on greening the PPP projects, less emphasis has been placed on green performance benchmarks of the outcomes of the projects. The existing green benchmarks are mostly on buildings with either no or confusing measures on projects such as roads, railways and services executed within the confines of the PPP arrangements [116]. How the ecological footprint and preservation of resources impact the performance of PPP projects have not been studied. In this regard, further studies on the performance of PPP projects must concentrate on analysing the green models and performance of other PPP projects aside buildings.

4. Another gap identified on the performance of PPPs is limited consideration of circularity of projects. The attention of the world is shifting from linear models of constructing projects to more circular models with the aim of cutting down waste [117]. Even though, the PPP concept has become widely acceptable in the delivery of public projects, the current performance measurement models on them correspond to the linearity of the project starting from pre-construction stage to the disposal of the project with little emphasis on



what happens next after the disposal or decommission stage [118]. Moreover, the few studies that applied circular economy models to PPP projects concentrated on only waste management not the entirety of the project and reusing the outcomes of the project [119]. This calls for research and development of holistic models to integrate circular economy models into the full lifecycle of the projects.



**Figure 4.** Areas that need more research in the sustainable performance measurement of PPPs.

## 5. Conclusions, Implications for Practice and Future Studies

In summary, the performance of PPP models in public infrastructural development is still essential topic in all sectors. The analysis and benchmarking within existing performance models of PPP projects needs a review in the light of UN SDGs. Systematically, this literature review identified 27 sustainable performance criteria of PPP projects from 33 relevant journal articles. The results reveal that reduction of costs, good project governance, environmental and green benchmarks and social diversity are the key performance criteria of PPPs.

The results set up measurement criteria and modelling to optimize the outcomes of PPP projects that are imperative to the performance targets of project managers. The findings of the study are useful guidelines in developing sustainable performance measures for PPP projects to meet the expectations of multiple stakeholders. The expectations of PPP infrastructure projects to protect the environment and consider the disabled persons have become paramount in recent discussions in the construction industry. Lessons from the review give credence to these discussions and provide a assessment performance measurement framework for managerial decision-making on the performance of PPP projects. The results encourage project managers to transition and develop sustainable performance measurement for in PPP projects. The bedrock of this transition is relevant information which is the driving force in good decision making and development of appropriate PPP project management policies. The findings are suitable source of information in achieving the transition from traditional performance measures to sustainable performance measures

in PPP projects. PPP projects are complex and distinctive in the financing arrangements with different partners, phases of the project and outcomes. Thus, the results of the study will coherent sustainable performance policies that facilitate long-term success with the focus on every facet of the PPP project. As a reference point, the outcomes of this study could facilitate further investigations and propositions of appropriate performance standards for PPP projects within the UN SDGs. Even though, the concept of PPP in construction project delivery has been around for decades now, it is evident from the literature review that few studies have focused on integrating sustainability principles in measuring the performance of PPP projects. Future research can build upon the findings of this study and establish specific sustainable performance measures to suit PPP projects in specific sectors such as roads, buildings, railways etc. From this study, future research will develop and expand the conceptual model proposed in this study, incorporate more relevant variables with testing and validation of the interrelationships between them.

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## Appendix A

**Table A1.** Publication details of selected articles.

Reference Number	Article (Author & Year)
1	Liu, et al. [120]
2	Kumar, et al. [121]
3	Akomea-Frimpong, et al. [114]
4	Kim and Thuc [122]
5	Osei-Kyei and Chan [123]
6	Hossain, Guest and Smith [42]
7	Liang and Wang [12]
8	Osei-Kyei and Chan [104]
9	Liu, et al. [124]
10	Osei-Kyei and Chan [125]
11	Osei-Kyei and Chan [126]
12	Liu, et al. [127]
13	Mohamad, et al. [128]
14	Osei-Kyei and Chan [129]
15	Osei-Kyei, Chan, Javed and Ameyaw [53]
16	Osei-Kyei and Chan [57]
17	Liu J., Love P.E.D., Sing M.C.P., Smith J., Matthews J. Liu, Love, Sing, Smith and Matthews [105]
18	Cappellaro and Ricci [130]

Table A1. Cont.

Reference Number	Article (Author & Year)
19	Koops, Bosch-Rekvelde, Coman, Hertogh and Bakker [56]
20	Liu, Love, Smith, Matthews and Sing [58]
21	Cuthbert and Magni [131]
22	Liyanage and Villalba-Romero [46]
23	Liu, Love, Davis, Smith and Regan [52]
24	Liu, Love, Davis, Smith and Regan [52]
25	Xiong, et al. [132]
26	Liu, Love, Smith, Regan and Palaneeswaran [63]
27	Mladenovic, Vajdic, Wündsche and Temeljotov-Salaj [49]
28	Zhou, Keivani and Kurul [59]
29	Yuan, Wang, Skibniewski and Li [10]
30	Yuan, Skibniewski, Li and Zheng [51]
31	Yuan, Zeng, Skibniewski and Li [50]
32	Shaoul [55]
33	Ismail, et al. [133]

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