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SUSTAINABILITY IN PPPS: A NETWORK ANALYSIS

GABRIEL CASTELBLANCO, JOSE GUEVARA, and PAULA MENDEZ-GONZALEZ

Dept of Civil and Environmental Engineering, Universidad de los Andes, Bogota, Colombia

Over the last decades, sustainability-related topics have increased their relevance to infrastructure development. Researchers have conducted studies analyzing the relationship between Public-Private Partnerships (PPPs) and sustainability. However, despite the PPPs have been recognized as a relevant factor for sustainable development, no bibliometric analyses have been conducted studying the relation between PPPs and sustainability. This paper introduces a comprehensive understanding of the body of knowledge of the nexus between sustainability and PPPs, their evolution, and the connections of their main topics. This analysis allows for integrating disperse studies within a comprehensive PPP-sustainable framework. The Network Analysis unraveled that the significance of sustainability within PPPs has grown over time evolving from traditional developed English-speaking countries to developing countries. Overall, the PPP research agenda has evolved from road infrastructure dominance driven by a public sector's perspective of social welfare to increasing types of infrastructure driven by economic and environmental performance yet remaining to strengthen the latter.

Keywords: Public-private partnership, Sustainable development goals (SDGs), Sustainability-related topics, Environment, Social.

1 INTRODUCTION AND BACKGROUND

By committing to the Sustainable Development Goals (SDGs), countries aim to pursue progress on economic, social, and environmental targets, in a balanced and integrated manner. However, the gap between the investment need and the actual investment is substantial and growing. To help fill this gap, public-private partnerships (PPPs) will be critical. They increase access to capital, allow off-balance sheet borrowing, increase innovation, and help transfer risks (Berrone *et al*. 2019, Castelblanco and Guevara 2020, Ruiz and Guevara 2020c).

PPPs allow for the supplying of facilities and relevant services such as communication, energy, sewage, healthcare, water, education, and transportation. Consequently, infrastructure provision has a relation with all the 17 SDGs, but especially with SDG11 (i.e., sustainable cities and communities), SDG9 (i.e., industry, innovation, and infrastructure), SDG7 (i.e., affordable and clean energy), SDG 6 (i.e., clean water and sanitation), and SDG 3 (i.e., good health and well-being for people) (Thacker *et al*. 2019).

The most accepted definition of sustainability integrates three main dimensions of it, economic (i.e., profit), environmental (i.e., planet), and social (i.e., people) (Koppenjan and Enserink 2009, Castelblanco *et al*. 2020, Rojas *et al*. 2020). These dimensions are related to the externalities derived by each of the phases of the PPP projects (Hueskes *et al*. 2017, Ruiz and Guevara 2020a, Ruiz and Guevara 2020b).

2 RESEARCH METHODOLOGY

The purpose of the current literature review aims for unraveling how the PPP body of knowledge has contributed to understanding sustainability-related topics in infrastructure development. Consequently, first, a systematic literature review was conducted. Second, the resulting papers were analyzed using VOSviewer®. Third, co-occurrence information results and network development were analyzed (Bautista *et al*. 2018, Guevara *et al*. 2020b).

2.1 Paper Selection, Filtering & VOSViewer® Analysis and Metrics

A bottom-up approach was employed for identifying articles in Web of Science database on PPPs integrating sustainability, which is consequent with prior research (Marsilio *et al.* 2011, Osei-Kyei and Chan 2015, Torchia *et al*. 2015, Cui *et al*. 2018, Wang *et al*. 2018, Song *et al*. 2019, Guevara *et al*. 2020a, Castelblanco *et al*. 2021). After this research process was held, an additional filter was included to exclude journals focused on unrelated research areas (e.g., immunology, sociology, health care sciences). As a result, 6,166 papers remained for the analysis. On the other hand, VOSViewer calculates a similarity matrix for developing co-occurrence of data, and a similarity matrix for mapping co-occurrences by optimizing the objective function of the Euclidean distances between every pair of nodes.

3 RESULTS AND DISCUSSION

The evolution of the research agenda of sustainability within PPPs over the last two decades was depicted in Figure 1. This agenda has systematically grown over time from 67 papers in 2,000 to 520 in 2019, demonstrating that the sustainability dimension has gained momentum and importance worldwide, especially in the last decade. Figure 2 shows a chronological evolution of sustainability within the PPP research agenda based on the countries where the research has been conducted in the last decade. The geographical epicenter of the research agenda has shifted from the traditional developed on English-speaking countries such as the US, United Kingdom, and Canada at the beginning of the decade, to medium-size developing countries in Africa, Asia, and America such as Tanzania, Ghana, Nigeria, Vietnam, and Colombia. On the other hand, in the mid-2010s, there is evidence of a transition driven by some of the biggest developing countries such as China and India, and other developed countries from Oceania and West-Europe.



Figure 1. Publications between 2000-2019 related to PPPs and sustainable-related issues.

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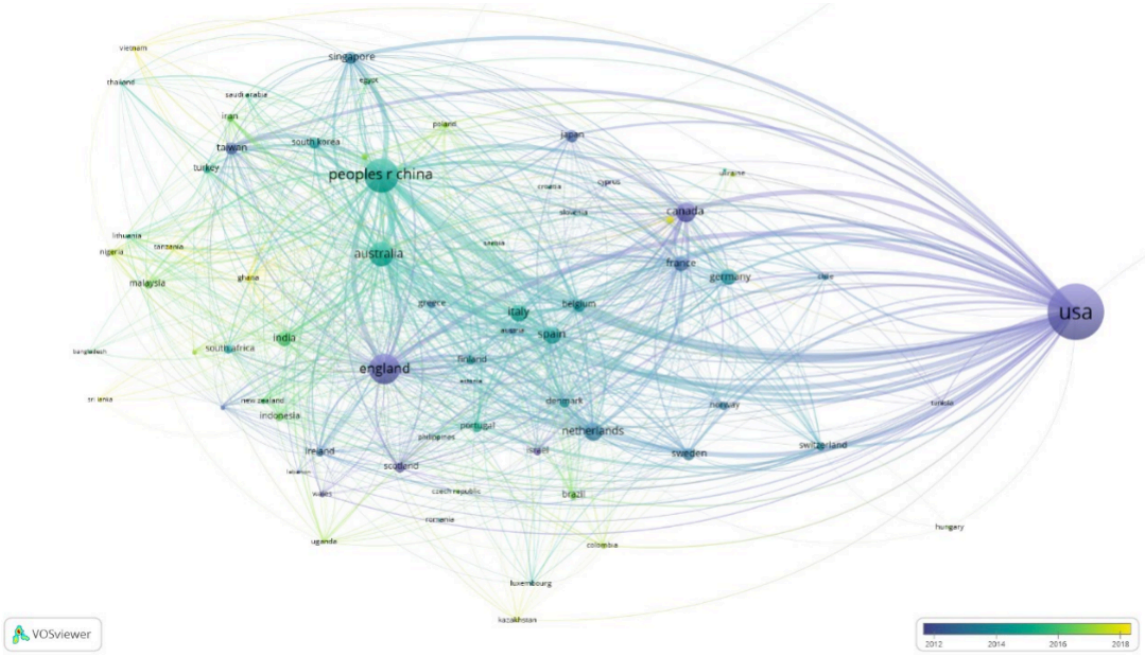


Figure 2. Countries' Network Evolution in the last decade.

In terms of network representation, Figure 3 depicts the main keywords' network of the PPP research agenda related to sustainability. The number of occurrences related to each keyword was represented in the network by the size of the node. Likewise, the thickness of the links increases as the number of links between two nodes also increases, respectively. This representation allows for identifying graphically the relevance of keywords within the research agenda on PPPs. Each one of the four colors of the nodes in the network represents a different type of cluster.

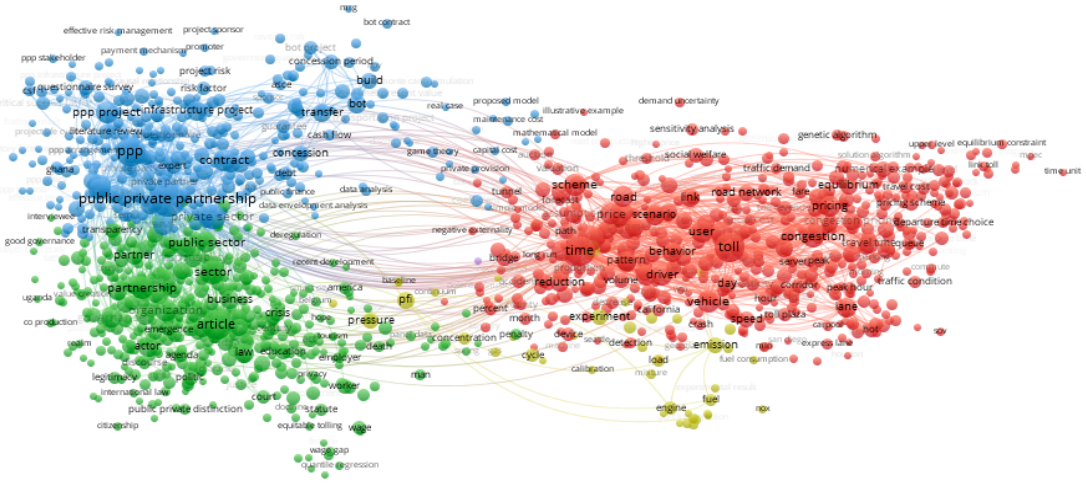


Figure 3. Main Keywords' Network related to sustainability within the PPP research agenda.

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Table 1 shows a description of each one of the clusters by including the main keywords according to their preponderance in occurrences and links. Network analysis unraveled that the research agenda can be classified into four different clusters. The biggest cluster (i.e., Cluster 1) is focused on road PPPs incorporating social, economic, and environmental dimensions of sustainability. On the other hand, the smallest cluster (i.e., Cluster 4) is focused on environmental sustainability, demonstrating the remaining gap for incorporating environmental considerations within PPPs that is likely triggered by financial restraints. Among those extremes, remain social and economic sustainability dimensions (i.e., Clusters 2 and 3) integrating responsible stakeholders (i.e., the public and private sectors) and impacted stakeholders (i.e., local communities and citizens).

Table 1. Cluster Interpretation (Adapted from Bautista *et. al*. (2018)).

Cluster	Keywords	Related Keywords
Cluster 1 **Cluster 1** Roads **Red** **527 Keywords**	Congestion	Environmental impact, congestion charge, congestion cost, congestion externality, congestion toll, congestion pricing, traffic, traffic forecast, truck traffic
	Facility	Road, toll highway, roadway, network, motorway
	Pricing	Toll, toll charge, toll price, tolling scheme, toll policy, road pricing scheme, pricing strategy, pricing policy, price elasticity, optimal pricing, fee
	Time-saving	Time, time period, time unit
	Vehicle	Truck, vehicle type, private car, electric vehicle
	User	Driver, car driver, truck driver, user heterogeneity, road user, passenger, heavy vehicle, choice experiment
Cluster 2 Social Sustainability/ Public sector **Green** **487 Keywords**	Governance	Governance system, good governance, leadership, legitimacy, trust, collaborative governance, administration
	Innovation	Innovation process, innovative solution
	Law	Litigation, private law, right, reform, norm, international law, institutional framework, federal court
	Public sector	Public accountability, public actor, public administration, new public management, public enterprise, public institution, public management, republic, publicness, public value, public ownership, public interest, national government, local government, federal government
	Collaboration	Partnership, coordination, cooperation, collective action, coalition, synergy, strategic alliance, interplay
	Social infrastructure	Public hospital, social housing, public school
	Sustainability	Social impact bond, social value, social capital, sustainable development, sustainable development goal, climate change
Cluster 3 Economic Sustainability/ Private Sector **Blue** **341 Keywords**	Contract	Contract design, contract management, contractual arrangement, PPP contract, long term contract, incomplete contract
	Economic/ Financial	Capital cost, capital structure, cash flow, commercial bank, construction cost, cost overrun, discount rate, financial feasibility, financial institution, financial market, financial model, financial risk, financial structure, financial support, financial viability, financing cost, investment return, net present value,
	Infrastructure	Infrastructure asset, infrastructure development, infrastructure service, new infrastructure, maintenance cost, concession contract, concession agreement
	Private sector	Private capital, private financing, private partner, private sector involvement, project company, sponsor, stakeholder, investor, contractor, concessionaire, bidder
Cluster 4 Environmental sustainability **Yellow** **41 Keywords**	Air	Emission, NOX, combustion, combustion process
	Fuel	Fuel consumption, gas, gasoline
	Engine	Cycle, port fuel injection, spark-ignition engine, timing, cylinder, direct injection, motion
	Metrics	Concentration, load, pressure, ratio, signal, calibration, degrees C,

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Finally, a cluster network analysis was made for unraveling the chronological evolution of the topics within the research agenda. This analysis revealed that the research agenda has evolved from Clusters 1 and 2 (i.e., roads, social sustainability, and public sector) in the 2000s to Clusters 3 and 4 in the last five years. Consequently, this finding suggests that the PPP research agenda has evolved from road infrastructure dominance (driven by a public sector perspective of social welfare) to an interest in understanding the economic and environmental performance, (driven for increasing efficiency and value creation for both, public and private sector).

4 CONCLUSIONS

PPP research agenda has been widely analyzed through bibliometric analyses. Nevertheless, these analyses have not thoroughly examined the relationships between PPPs and sustainability. This paper aims to fill this gap by conducting a systematic literature review for analyzing on a network basis how the PPP body of knowledge has contributed to sustainability.

The findings show that the interest in sustainability-issues related to PPPs has systematically grown over time, demonstrating that the sustainability dimension is strengthened worldwide as time passes, especially in the last decade. Overall, the PPP research agenda has evolved from road infrastructure dominance driven by a public sector's perspective to increasing types of infrastructure driven by economic and environmental performance, yet remaining to strengthen the latter, aiming for growing efficiency and value creation aim for both, public and private sector. This is important because involving the private sector can: (i) increase the stock of infrastructure assets; (ii) strengthen the resilience of the parties involved in the procurement process; (ii) create more sustainable solutions; and (iv) improve access to infrastructure services. PPPs are rooted in the same integrated approach as the SDGs: each component must be pursued as an integral part of the whole to achieve the expected outcomes.

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References

Bautista, S., Camargo, M., Morel, L., and Bachmann, C., *Sustainable Management of Roadside: Towards a Research Agenda*, 2018 IEEE International Conference on Engineering, Technology and Innovation, ICE/ITMC 2018 - Proceedings, IEEE, 1–9, June 17-20, 2018.

Berrone, P., Ricart, J. E., Duch, A. I., Bernardo, V., Salvador, J., Peña, J. P., and Planas, M. R., *EASIER: An Evaluation Model for Public-Private Partnerships Contributing to the Sustainable Development Goals*, Sustainability, 11(8), 2339, April, 2019.

Castelblanco, G., and Guevara, J., *Risk Allocation in PPP Unsolicited and Solicited Proposals in Latin America: Pilot Study in Colombia*, Construction Research Congress 2020, 1321–1329. doi: 10.1061/9780784482889.141. November, 2020.

Castelblanco, G., Guevara, J., Mesa, H., and Flores, D., *Risk Allocation in Unsolicited and Solicited Road Public-Private Partnerships: Sustainability and Management Implications*, Sustainability, 12(11). doi: 10.3390/su12114478. June, 2020.

Castelblanco, G., Guevara, J., Mesa, H., and Sanchez, A., *Semantic Network Analysis of Literature on Public-Private Partnerships*, Journal of Construction Engineering and Management, 147(5). doi: 10.1061/(ASCE)CO.1943-7862.0002041. May, 2021.

Cui, C., Liu, Y., Hope, A., and Wang, J., *Review of Studies on the Public – Private Partnerships (PPP) for Infrastructure Projects*, International Journal of Project Management, Elsevier Ltd and Association for Project Management and the International Project Management Association, April, 2018.

Guevara, J., Garvin, M. J., and Ghaffarzadegan, N., *The Forest and the Trees: A Systems Map of*

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Governance Interdependencies in the Shaping Phase of Road Public-Private Partnerships, Journal of Management in Engineering, 36(1), 1–16. doi: 10.1061/(ASCE)ME.1943-5479.0000726. January, 2020a.

Guevara, J., Salazar, J., and Garvin, M. J., *Social Network Analysis of Road PPP Equity Markets in Canada, Chile, and the United States*, Journal of Management in Engineering, 36(5), 04020058. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000830. September, 2020b.

Hueskes, M., Verhoest, K., and Block, T., *Governing Public–Private Partnerships for Sustainability. An Analysis of Procurement and Governance Practices of PPP Infrastructure Projects*, International Journal of Project Management, Elsevier Ltd, APM and IPMA, 35(6), 1184–1195, August, 2017.

Koppenjan, J. F. M., and Enserink, B., *Public–Private Partnerships in Urban Infrastructures: Reconciling Private Sector Participation and Sustainability*, Public Administration Review, January, 2009.

Marsilio, M., Cappellaro, G., and Cuccurullo, C., *The Intellectual Structure of Research Into PPPs*, Public Management Review, 13(6), 763-782, February, 2011.

Osei-Kyei, R., and Chan, A. P. C., *Review of Studies on the Critical Success Factors for Public – Private Partnership (PPP) Projects from 1990 to 2013*, JPMA, Elsevier Ltd., March, 2015.

Rojas, R., Bennison, G., Gálvez, V., Claro, E., and Castelblanco, G., *Advancing Collaborative Water Governance : Unravelling Stakeholders' Relationships and Influences in Contentious River Basins*, Water, 12(12), 3316. https://doi.org/10.3390/w12123316. November, 2020.

Ruiz, A., and Guevara, J., *Environmental and Economic Impacts of Road Infrastructure Development: Dynamic Considerations and Policies*, Journal of Management in Engineering, 36(3), 4020006. doi: 1061/(ASCE)ME.1943-5479.0000755. May, 2020a.

Ruiz, A., and Guevara, J., *Sustainable Decision-Making in Road Development: Analysis of Road Preservation Policies*, Sustainability, 12(3), 872. https://doi.org/10.3390/su12030872. January, 2020b.

Ruiz, A., and Guevara, J., *Adoption Dynamics of Carbon Abatement Strategies in the Colombian Office Building Sector*, Construction Research Congress 2020: Infrastructure Systems and Sustainability, 781-790, Reston, VA: American Society of Civil Engineers. https://doi.org/10.1061/9780784482858.084. 2020c.

Song, J., Li, Y., Feng, Z., and Wang, H., *Cluster Analysis of the Intellectual Structure of PPP Research*, Journal of Management in Engineering, 35(1), 1–15, January, 2019.

Thacker, S., Adshead, D., Fay, M., Hallegatte, S., Harvey, M., Meller, H., O'Regan, N., Rozenberg, J., Watkins, G., and Hall, J. W., *Infrastructure for Sustainable Development*, Nature Sustainability, 2(4), 324–331, April, 2019.

Torchia, M., Calabrò, A., and Morner, M., *Public–Private Partnerships in the Health Care Sector: A Systematic Review of the Literature*, Public Management Review, 17(2), 236–261, February, 2015.

Wang, H., Xiong, W., Wu, G., and Zhu, D., *Public–Private Partnership in Public Administration Discipline: A Literature Review*, Public Management Review, Routledge, 20(2), 293–316, February, 2018.

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