© APR 2026 | IRE Journals | Volume 9 Issue 10 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I10-1716141

Public-Private Partnerships (PPP) In the Digital Economy: Financing Models for Infrastructure and Platform-Based Investments

IMRAN SAEE MUHAMMED
ORCID: 0009-0007-6205-7845

Abstract- ***There are two primary asset classes that play an important role in modern digital economies: (i) digital infrastructure (pipes, towers, cloud capacity, and data center facilities); and (ii) platform services coordinating their delivery (government clouds, "government as a service" APIs, digital identity, payments and data transmission mechanisms). Not only have public-private partnerships (PPPs) evolved from "pipelines" procurement vehicles, but have increasingly become funding and governance structures for platforms where value lies in the dynamics of network effects, trust and interoperability. The purpose of this literature review is to compile information about financing frameworks for digital economy PPP projects in 2020-2025. In addition to exploring how the design of payment logic and governance can affect the financing outcomes in terms of bankability, fiscal risks, and public value, special attention will be paid to PPP-related risks specific for the digital economy.According to PRISMA 2020 methodology [1], sources related to this topic will be identified using multilateral papers on fiscal risks and PPP ecosystems [2–6], government digital strategy and data governance documents [11–13] and DPI initiatives in international platforms [14–17]. In addition, scholarly sources on digital technology-based PPPs in smart infrastructure and platforms [19-27] will be analyzed. One can notice that while risk allocation in traditional PPP deals mostly revolved around issues of construction, materiality and transactions; in the digital economy, it involves issues of adoption, cybersecurity, data rights, vendors and obsolescence. Neglecting such risks can lead to capital cost savings and unsatisfactory results, which in turn leads to renegotiations and fiscal risks [2,3].Contributions include (a) conceptual framework for digital economy PPPs (Figure 1); (b) an overview of financing opportunities for infrastructure and platform investments (Table 1); and (c) a guide for developing financing frameworks in relation to government investment in digital economy assets.***

Index Terms- ***Public-Private Partnership; Digital Economy; Digital Infrastructure; Broadband; Data Centres; Government Cloud; Digital Public Infrastructure; Platform Governance; Fiscal Risk; Procurement; Interoperability; Cybersecurity; Performance-Based Payment.***

I. INTRODUCTION

The use of digitalisation in logistics processes has evolved from an efficiency programme to a key determinant of performance, competitiveness and even wellbeing of citizens. Connectivity and data platforms help coordinate flows, minimise dwell time and maximise traceability; interoperable digital systems are critical for the reliability of large-scale public service transactions. These innovations hinge upon different types of investments than those associated with traditional infrastructure. Fibre backbone requires low-cost and lengthy maintenance, while service platform has to be updated perpetually. Income from tower can be secured by contractual arrangements, whereas public services portal gains its value from user adoption.In recent years, the infrastructure finance environment has undergone significant fluctuations, which have impacted interest rates and risk appetites [4,7-10]. The analysis suggested that investment strategies differed by type of sector and region, and that more digital infrastructure was incorporated into investment cycles. Hence, one can conclude that governments would not be able to apply the same PPP format in every instance. They should use various forms of PPPs along with appropriate risk management mechanisms based on demand, financial capacity and state of digital infrastructure development. Simultaneously, there is another set of challenges associated with the nature of digital infrastructure itself. The concentration of power, inherent to platforms, could become a problem if the platform

© APR 2026 | IRE Journals | Volume 9 Issue 10 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I10-1716141

accumulates excessive information resources. According to OECD report, the maturity of digital government relies on the ability of "government as a platform", proper use of data and sound governance across organisations [11]. Governance of data becomes an element of financing because uncertainties associated with rights, obligations and cross-country policies impact investment decisions [13]. Digital Policy Innovation (DPI) initiatives around the world consider foundational digital systems to be common rails utilised by private and public actors and stress the importance of safe and inclusive governance, which promotes delivery and innovation [14-17]. Such considerations become important financially material aspects in PPPs, as they affect operations, risks, and adoption.

There is yet another constraint to consider, which is related to budgetary limitations. Public-Private Partnerships are implemented precisely for the reason that public spending is limited. However, fiscal risk is often understated in case of non-balanced or contingent obligations [2,3]. Fiscal risk poses particular danger in the case of platform-based project as operating costs incurred over multiple years are inevitable, such as cybersecurity, maintenance and scalability costs. Lack of clarity in contractual provisions may result in decreased quality of service and renegotiations or disputes between parties, even forcing public spending. The scale of digital infrastructure investment underscores the urgency of getting PPP design right. World Bank PPI data show that digital infrastructure — telecommunications, data centres, and broadband networks — grew from under 10% of total global PPI commitments in 2019 to over 20% by 2023, with cumulative private investment in the sector reaching approximately USD 120 billion across low- and middle-income countries over the 2020–2023 period [7, 8, 9, 10]. The GovTech Maturity Index (2022) documents that over 170 governments were actively investing in shared digital platforms and government cloud infrastructure during this period, yet fewer than 40% had established formal procurement frameworks capable of managing the lifecycle operational risks these investments entail [6]. This gap between investment volume and governance readiness is the central financing problem this paper addresses.This paper addresses the following question: What types of PPP financing are employed or suggested for digital infrastructure and platform-based projects, and what measures are taken for ensuring balance between mobilisation of private capital and safeguarding public value? This review is based on the perspective of Scopus/Q1 logistics journals with emphasis on performance and replicable contract design.

II. PURPOSE AND GOALS OF RESEARCH

Purpose. To consolidate the state of knowledge on financing frameworks for PPP projects related to investments in digital economy infrastructure and systems (platform), taking into consideration financial benefits, risk mitigation measures and the creation of public value and to develop recommendations for PPP design that strikes a balance between the mentioned aspects. Goals.

(1) Classification of investment object and economic attributes, such as connectivity vs. platforms (fibre, towers, data centres vs. cloud services, digital identity, payment systems, digital exchanges) and explanation of reasons why it matters for bankability.
(2) Discussion of how PPP payment mechanism (availability-based, wholesale, revenue share, outcome-based, subscription model) influences demand, adoption, cybersecurity and data governance risk distribution [2,3,11–13].

(3) Identification of financing methods and investor strategy used in PPPs, including traditional project finance approach, blended approaches and other financing models based on measurable KPI [4,7–10,28–30].

(4) Definition of KPIs related to platform operations and ways to avoid conflicts and facilitate audit of platform performance (measurable and verifiable service level reports, security audits, KPI measurement) [1,2,17,19].

(5) Development of implementation roadmap and research agenda with respect to management in infrastructure and logistics literature.

© APR 2026 | IRE Journals | Volume 9 Issue 10 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I10-1716141

III. METHODOLOGY

3.1 Design and Reporting

Thematic synthesis with narrative approach design is employed. PRISMA 2020 will be used as a scaffolding to ensure transparency in criteria and logic [1]. Meta-analysis using quantitative approach cannot be implemented because of extremely high heterogeneity of the evidence base: fiscal risks guidance by IMF/World Bank [2,3]; investment monitoring and PPP ecosystem benchmarking [4-10]; digital government policy of OECD [11-13]; DPI principles and safeguards [14-17]; and academic papers on digital PPPs and platform governance [19-27].

3.2 Scope and Selection

Literature on PPPs and procurement for 2020-2025 period is carefully reviewed to identify papers relevant to PPP risk management within digital economy (infrastructure of broadband connectivity, cloud platforms and services ecosystem). Publications on institutions are selected if they provide decision support, ecosystem benchmarks, standards or widely accepted guidelines for PPP risk management. Papers on academia are selected if they include typologies or empirical evidence.

3.3 Procedure

Evidence is categorized into 4 groups: (i) investment objects and cash flows; (ii) risk allocation and fiscal risks; (iii) financing mechanisms; (iv) assurance and performance measurement. Synthesis of the evidences follows Figures 1 and Table 1. Platform issues, including those of data governance, interoperability and exit options, should be addressed as financial problems, not as policy ones.

IV. CONCEPTUAL FRAMEWORK FOR PPPS IN THE DIGITAL ECONOMY

4.1 What is PPP in the Digital Economy?

PPPs in the digital economy could be addressed from 2 perspectives: first, commitment perspective and second, co-ownership of technology and data. Traditional PPP was based on tangible assets delivering results in line with agreements on asset use. However, in digital PPPs, apart from tangible assets making the core of digital infrastructure, there is much more intangible elements of services depending largely on platform governance and user adoption rate.The subjects of investments in PPPs could be classified into 2 categories. On one hand, these are connectivity assets (networks of fibers, backhauls, tower site and data center), which could be easily identified in traditional PPPs. Tangible assets enable certain commitments made based on capabilities of the assets, however, they always have a risk to be obsolete and compete with each other [4]. On the other hand, these are assets in form of platform: governmental cloud services, API/services buses, digital identity infrastructure, payment rails and data exchange layer, which is indispensable to deliver other services. Given the DPI perspective, these are shared systems, which require certain level of cybersecurity, interoperability and trust to operate properly [14-17]. Therefore, digital PPPs should pay attention not only to "asset availability" but also to "platform capability and trust".

4.2 Why risk allocation changes in case of PPP platforms

Unlike traditional PPP where risks were mainly related to construction, demand and operation & maintenance risks, risks in digital PPP shift into adoption risks, usage risks and even security risks. As it appears from the OECD report, implementation of the "government as a platform" idea requires integration of all government data and services, it would not work otherwise; that adds another layer of uncertainties to the risk landscape [11]. Moreover, data governance raises another type of risk in regard to data use and sharing, and cross-border data flows, thus affecting cost calculations [13].In turn, fiscal risks transform dramatically. Availability payments lead to multi-year annuity obligations for broadband and cloud services; revenue-sharing model creates motivation for the operator to take advantage of users against public interest; and output contracts entail certain risks for the provider but require sophisticated verification mechanisms [2,3]. As reported by the IMF, fiscal illusion tends to appear when "free infrastructure" is considered; moreover, contingencies and renegotiations are always possible [2].

© APR 2026 | IRE Journals | Volume 9 Issue 10 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I10-1716141

4.3 The role of platform governance in PPP projects

A distinguishing feature of PPP in digital world is that the governance aspect gains importance as much as interest rate. Portability and interoperability requirements determine if the ecosystem will be open or closed. According to OECD report, the proper balance should be struck between openness and closing the data. Contracts might help, as reported in OECD paper [13]. In the DPI principles, DPI is regarded as a governance issue, not an end in itself [17].Thus, altogether the consideration leads to the conclusion that digital PPP projects acquire 4-level complexity: service objectives setting, risk allocation, financing design and platform governance. It is depicted in Figure 1. Table 1 contains mapping of financing models to risks and KPIs.

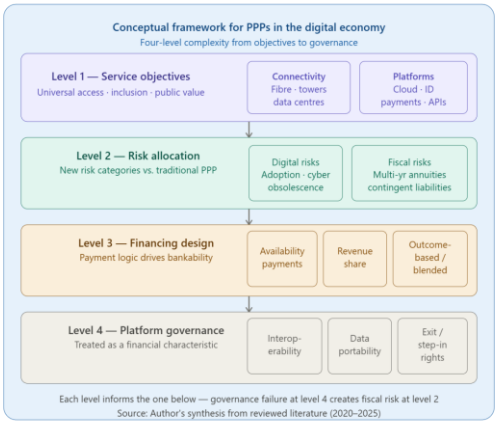


Figure 1. Conceptual framework for PPPs in the digital economy: four-level complexity from service objectives to platform governance. The framework illustrates that each level informs the one below — a governance failure at Level 4 (platform lock-in, absent exit rights) propagates upward to create fiscal risk at Level 2 and financing failure at Level 3. Connectivity assets (fibre, towers, data centres) and platform assets (cloud, digital ID, payments, APIs) require different treatment at each level. Source: Author's synthesis from reviewed literature (2020–2025).

Table 1. PPP financing models for digital infrastructure and platform-based investments: payment logic, risk allocation, and key performance metrics (2020–2025 synthesis).

PPP / financing model	Typical investment object	Revenue / payment logic	Core risk allocation	Financing instruments commonly used	Operational KPIs	When it tends to work best
Availability-payment broadband PPP (DBFOM)	Fibre/backhaul; rural coverage	Availability + quality bonuses	Demand risk (public); performance risk (private)	Long-tenor debt; guarantees; milestone payments	Coverage %, uptime, latency, fault repair times	Best where demand uncertainty is high but service is essential
Wholesale open-access network	Metro fibre; towers; neutral host	Wholesale access fees	Demand &competition risk shared via	Project finance + anchor tenants	Wholesale take-up, price caps, nondiscriminati	Aligns with competition and platform ecosystem

concession			regulation		on	growth
Revenue-share digital platform PPP	Gov service portal; licensing; data exchange	Fees + revenue share; sometimes capped	Adoption risk shared; governance risk high	Opex-heavy contracts; variable remuneration	User adoption, service completion rates, grievance response	Fit where monetization is feasible and governed
Outcome-based (impact) contracting	Digital ID, payments rails, digital inclusion	Payments tied to verified outcomes	Risk on provider; verification critical	Working-capital finance; performance guarantees	Verified identities, usage, error rates, fraud metrics	Useful when outputs are measurable and benefits diffuse
Government cloud / managed services partnership	Hosting + cybersecurity + shared services	Subscription/service fees	Operational & cyber risk shared; lock-in risk	Framework agreements; capacity reservation	Availability, incident response, compliance audits	Requires strong procurement and exit/portability clauses
Blended-finance DPI scaling (public + DFI + private)	Foundational platforms + capacity building	Mixed: grants + concessional + commercial	Risk layered; fiscal transparency essential	Guarantees; subordinated concessional layer	Inclusion, resilience, interoperability milestones	Mobilizes capital in high-risk contexts
Smart-city data platform PPP (city-as-a-platform)	IoT networks; urban data hubs	Service fees + optional revenue streams	Data/privacy risks; vendor power	Hybrid: capex + opex; step-in rights	Data governance KPIs, privacy-by-design compliance	Needs transparent governance and public-values clauses
Asset recycling for digital infrastructure	Operating fibre/towers/data centers	Upfront proceeds; leaseback/management fees	Reinvestment risk; political risk	Sale/leaseback; infrastructure funds	Service levels, investment commitments, clawbacks	Frees public capital while safeguarding continuity

V. EVIDENCE SYNTHESIS: FINANCING MODELS IN PRACTICE

5.1 Availability-payment models for universal connectivity

The availability payment financing model is used in cases when universal service objectives prevail, and unpredictable/demand that is unaffordable is considered. In the terms of DBFOM, the government buys availability and reliability (uptime, latency, etc.) from the operator instead of relying on the actual demand. Thus, availability-pay PPPs provide cash flow predictability, which can be utilized for debt financing. Yet, the fiscal risks related to commitments should be carefully addressed by ensuring proper budgeting and monitoring of such investment portfolio. Fiscal risk management best practices are elaborated on at length in the corresponding recommendations [2,3]. The European Commission guide for broadband investments mentions that "the investment model" decided upon by the public authority refers to "decisions about whether the infrastructure will be owned publicly or privately and its operation, including financial and

monitoring tools to support the deployment of broadband infrastructure" [18].

5.2 Wholesale open-access and neutral-host concessions

Due to market-building, competition and necessity for open interfaces, an open-access wholesale PPP option becomes especially appealing. In such case, the operator collects the fees for provisioning services, with non-discrimination clauses, which ensure third party access to the infrastructure. The ecosystem of various applications and multiple downstream providers can be supported by the open architecture and open access to the platform. Logistics and smart cities are among the applications that can make good use of the multiple providers' connectivity network.

5.3 Revenue-share and platform concession approaches

PPP models employing revenue-sharing, subscription, or other type of service payment, that includes transactions fees, licensing fees, or payment rails for the government services portal or any similar platform can be applied. As it can be understood, the main problem of such type of PPP is adoption: people may become afraid of misuse of their personal data and, therefore, refrain from using the application altogether. DPI policy statements stress the importance of inclusivity and privacy [14] and emphasize the need for openness of architecture.

5.4 Outcome-based and impact contracting

Outcome or impact PPP is applicable in situations when the outputs and benefits can be clearly measured among the parties involved. The digital ID enrollments, digital payments transactions, or use of electronic services by small business entities, for example, can become the outputs of interest. Payments will then be contingent on reaching certain goals or milestones. The benefit of the outcomes-based contract is obvious: better incentive structure and lower risks of getting billed for the "shelfware". Verifying the outputs might become problematic, however, with the risk of perverse incentives because of incorrect metrics. The guidelines of sustainable finance stress the importance of materiality, measurability and independence of key performance indicators [28-30].

5.5 Blended finance for platform scaling

As a financing tool, blended finance can be used in developing nations where the per capita income is low or the political situation unstable enough not to allow purely commercial investors to participate. It was shown by PPI monitoring that development banks had a significant role to play in shock cycles or in the recovery periods after disasters [7-10]. Blended finance will allow concessional and other forms of protection from losses to be added, hence attracting commercial finance.

VI. BANKABILITY, INVESTOR STRATEGY, AND SUSTAINABLE FINANCE INSTRUMENTS

6.1 Matching instrument to asset and revenue risk

The practice of investment monitoring indicates that under tighter financial conditions investors prefer safer strategies and de-risked assets [4]. In regard to digital PPPs, that means greenfield projects need more risk mitigation, whereas operating assets are suitable for refinancing through bonds or institution lending. Asset recycling (disposal or leasing with investment commitments of existing assets) allows the release of capital but requires clawback and service safeguarding.

6.2 Relevance of sustainable finance to digital PPPs

Financing of infrastructure development using sustainable finance instruments is applicable in cases where projects contribute to social inclusion, energy efficiency or climate adaptation. Principles for sustainable finance include recommendations on linking financing to performance criteria that should be relevant, verifiable, and reported [29]. In case of financing via loans, sustainability-linked loan principles also apply [30]. In digital PPPs, these criteria are valuable in two respects: they allow to expand investor pools, and improve the reporting standards reducing conflicts (e.g., independent auditing of inclusion and service metrics).

6.3 Prevention of lock-in and continuity protection

Smart infrastructure PPP research demonstrates that technology-based projects may generate dependencies and raise governance issues related to public values and accountability [20,21]. Research on smart cities' partnerships also illustrates the influence

© APR 2026 | IRE Journals | Volume 9 Issue 10 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I10-1716141

of private technology providers on policy decisions, which makes the sphere of procurement and contractual agreements become the focus of governance [21]. From the logistical point of view, lock-in increases the risk since inability of timely exit leads the public sector to accept the decreasing performance.Contractual levers that should be used include requirements to modular architecture, API, and other open standards, data portability, escrow and step-in rights for critical software, as well as reporting requirements. In its guidance on data governance, OECD refers to using model contracts and clauses to balance the overlaps and regulatory risks [13]. These clauses should be viewed as credit characteristics, as they decrease the likelihood of the service delivery disruption and reputation impact, which affects both fiscal stability and investors' return.

VII. ASSURANCE AND PERFORMANCE METRICS: MEASURING SERVICE DELIVERY IN DIGITAL PPPS

One of the consistent themes among the fiscal risk management guidance and platform governance literature is that uncertainty is priced and assurance decreases uncertainty. According to IMF, a sound fiscal risk management approach would include identification of contingent liabilities and stress testing of PPPs portfolios [2]. Stress test for the digital economy should consider such risks as cyber attacks, low user adoption rate, failure of vendor solvency, and technology obsolescence.

7.1 Choosing performance metrics for digital PPPs

KPI selection needs to address service-related outcomes such as coverage, uptime, latency, transaction completion rate, and inclusion indicators (rural users transaction rate). The danger here is metric gaming, which can be prevented by the application of sustainability-linked standards. Sustainability principles require KPIs to be material, quantifiable, and externally verifiable [29,30]. DPI safeguards require special attention to accountability and guarantees of rights and inclusion [17]. As applied to PPPs, this translates into three major provisions: (i) audit rights; (ii) transparent reporting process; and (iii) proportionate remedies (service credits, penalty regime and termination clause).

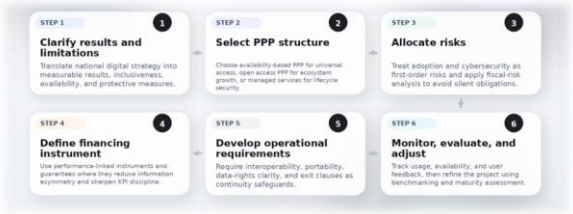
7.2 Cybersecurity and resilience as deliverables

In order to be sustainable, digital PPPs have to make cybersecurity an integral part of the service. "Once-only compliance" is not sufficient for multiyear contracts. Managed services partnership, therefore, has to be accompanied by such deliverables as incident response SLAs, mandatory vulnerability management and continuous monitoring arrangements. Partnership and resilience research on public-private collaborations in critical infrastructure suggests that the purpose of partnership is different than typical PPP procurement; it is concerned with cooperation between the government and operators during unexpected events [25]. This implies that management of disruptions has to become an integrated component of the payment logic: rewards for prompt recovery and penalties for mismanaging cyber incidents, as well as requirement to cooperate with national cyber security agencies.

7.3 Portfolio visibility and learning

Benchmarking in PPP ecosystems pays considerable attention to institutional capacity and regulatory frameworks as determining factors for project outcomes [5]. In digital PPPs, it means capacity to engage in technology procurement, data governance, and measurement of platform usage. Maturity assessment of GovTech initiatives underscores the importance of monitoring of shared platforms usage and reporting results, besides developing solutions themselves [6]. Logistically sound PPP programme should ensure that adequate measurement infrastructure (dashboards, analytical reports) is developed.

VIII. DIGITAL ECONOMY PPP IMPLEMENTATION ROADMAP



Step 1. Clarify desired results and limitations. Interpret digital strategy of the country with regard to tangible, measurable results, inclusiveness, availability, and protective measures [11,14,17].

© APR 2026 | IRE Journals | Volume 9 Issue 10 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I10-1716141

Step 2. Select PPP structure. Go for availability-based PPP in case there is a need for universal accessibility of infrastructure; opt for open access PPP if competition and growth of the ecosystem are vital; use managed services PPP for lifecycle security.
Step 3. Allocate risks. Make adoption rate and cybersecurity risks first-order risks. Apply fiscal risk analysis to address "silent risk" issue [2,3].
Step 4. Define financing instrument and guarantees. Use performance-linked models if it is possible to do because of their efficiency in reducing information asymmetry and ensuring proper key performance indicator setting [29,30].
Step 5. Develop operational requirements. Require interoperability and portability; identify data rights and exit clauses. These criteria should be viewed as continuity measures, not policy measures [13,17].
Step 6. Monitor, evaluate and adjust the project. Monitor usage, availability and user feedback. Assess achievements with benchmarking and maturity assessment; this will help enhance procurement competency [5,6].

IX. RESEARCH GAPS AND FUTURE DIRECTIONS

While the use of digital PPP grew during the period between 2020 and 2025, there were three major gaps found in literature in this area.

First, there is a lack of studies that take into account governance and adoption risks and treat PPPs only as financial tools for digital infrastructure as opposed to traditional infrastructure. Most existing reviews apply standard project finance frameworks to digital assets without adjusting for the fundamentally different risk profile of platform-based investments. This gap requires further empirical research on the impact of interoperability and portability conditions on financing costs and renegotiation frequency. A promising approach would be a cross-country panel study using World Bank PPI portfolio data [7–10] matched against contract-level provisions on data portability and interoperability, controlling for jurisdiction and asset type.

Second, there is no focus in smart city research on the economic aspects of public value trade-offs made in digital infrastructure investment decisions [20–23]. Current literature documents governance failures and accountability gaps, but rarely quantifies the fiscal cost of lock-in, platform monopolisation, or service degradation in economic terms. Future research should develop a methodology for estimating the total cost of ownership — including renegotiation costs, exit costs, and service disruption costs — for a standardised sample of smart city PPP contracts, to provide procurement authorities with decision-relevant benchmarks.

Finally, operational research related to digital platforms often addresses cross-platform spillover effects and alignment of digital and physical infrastructure, but lacks empirical research on the link to investment decisions under PPP [26]. In the logistics domain, research may address the impact of platform reliability and information exchange on supply chain performance, and how PPP agreement design enables or constrains these interdependencies. Methodologically, mixed research combining portfolio databases such as the World Bank PPI series, contract design features, and operational performance criteria would allow stronger causal inference. Additionally, there is a need for transparency about the cost of cyberattacks and service disruptions in PPPs [25] — currently this data is rarely disclosed, making it impossible to price cyber risk accurately in long-term contracts or to benchmark resilience performance across programmes.

CONCLUSION

To facilitate both platform and infrastructure investment in digital economy PPPs, it is necessary to take platform investments into account. The evidence obtained in the above sections suggests that successful application of PPP projects in the digital economy does not depend on capital expenses as much as on creating reliable continuity system that includes stable operation funding, performance measurement systems, data rights and portability clauses, and fiscal transparency that would avoid silent fiscal obligations [2,3,6,13,17]. Availability-based financing model works perfectly when there is

a need for universal accessibility of infrastructure, whereas open access and managed service PPPs are good options for ecosystems. For platform investments, revenue sharing and outcome contracts can be taken into account, but only when governance, auditability, and adoption challenges are addressed.For policy makers and investors, platform governance must be seen as a factor promoting bankability. Requirements for portability, interoperability, and auditability have to be viewed the same way as technical characteristics are. Researchers should concentrate on economic consequences of particular platform governance strategies and development of scalable contract templates. Especially crucial is professionalization of public contract management in the realm of technology services because the value lies in operations.

REFERENCES

[1] Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71.

[2] Fouad M, Rial I. Mastering the Risky Business of Public-Private Partnerships in Infrastructure. IMF Departmental Paper No. 2021/010. 2021. doi:10.5089/9781513576565.087.

[3] World Bank. Fiscal Risk in PPPs: Defining the Problem. PPP Knowledge Lab. 2020.

[4] World Bank. Infrastructure Monitor 2023: Global Trends in Private Investment in Infrastructure. 2023.

[5] World Bank. Benchmarking Infrastructure Development 2023 (BID 2023): The Full Report. 2024.

[6] World Bank. GovTech Maturity Index Update 2022. 2022.

[7] World Bank. PPI Database Global Report 2021. 2021.

[8] World Bank. PPI Database Global Report 2022. 2022.

[9] World Bank. PPI Database Global Report 2023. 2023.

[10] World Bank. PPI Database Global Report 2024. 2024.

[11] OECD. Digital Government Index: 2019 results. OECD Public Governance Policy Papers No. 3. 2020. doi:10.1787/4de9f5bb-en.

[12] OECD. Development Co-operation Report 2021: Shaping a Just Digital Transformation. OECD Publishing. 2021. doi:10.1787/ce08832f-en.

[13] OECD. Going Digital Guide to Data Governance Policy Making. OECD Publishing. 2022. doi:10.1787/40d53904-en.

[14] G20. G20 New Delhi Leaders' Declaration. 2023.

[15] World Economic Forum. What we can expect for digital public infrastructure in 2024. 2024.

[16] UNDP. The human and economic impact of digital public infrastructure. 2023.

[17] UNDP. UN releases Universal DPI Safeguards Framework to promote safe and inclusive digital public infrastructure. 2024.

[18] European Commission. Broadband Investment Handbook. 2024.

[19] Tolstolesova L, Glukhikh I, Yumanova N, Arzikulov O. Digital transformation of public-private partnership tools. Journal of Risk and Financial Management. 2021;14(3):121. doi:10.3390/jrfm14030121.

[20] Selim AM, ElGohary AS. Public–private partnerships (PPPs) in smart infrastructure projects: the role of stakeholders. HBRC Journal. 2020;16(1):317–333. doi:10.1080/16874048.2020.1825038.

[21] Voorwinden A. The privatised city: technology and public-private partnerships in the smart city. Information, Communication & Society. 2021;24:439–463. doi:10.1080/17579961.2021.1977213.

[22] Pianezzi D, Mori Y, Uddin S. Public–private partnership in a smart city: a curious case in Japan. Cooperation and Conflict. 2023;89(3). doi:10.1177/00208523211051839.

[23] Quan X, Solheim MCW. Public-private partnerships in smart cities: a critical survey and research agenda. City, Culture and Society. 2023;32:100491. doi:10.1016/j.ccs.2022.100491.

[24] Casprini E, Palumbo R. Reaping the benefits of digital transformation through public-private partnership: a service ecosystem view applied to healthcare. Global Public Policy and Governance. 2022. doi:10.1007/s43508-022-00056-9.

[25] Shahid H, et al. Exploring the concept of public-private partnership in building critical infrastructure resilience against unexpected events: a systematic review. International Journal of Critical Infrastructure Protection. 2022;39:100556. doi:10.1016/j.ijcip.2022.100556.

[26] Joglekar N, Anderson EG, Lee KB, Parker G, Settanni E, Srai JS. Configuration of digital and physical infrastructure platforms: private and public perspectives. Production and Operations Management. 2022;31(12). doi:10.1111/poms.13865.

[27] Mayer M, Yusuf JEW. Structuring public–private partnerships for public value: analysis of two transportation infrastructure case studies. American Review of Public Administration. 2022;27(3). doi:10.1177/1087724X221075010.

[28] International Capital Market Association (ICMA). Sustainability-Linked Bond Principles. 2024.

[29] Loan Syndications and Trading Association (LSTA), Loan Market Association (LMA), Asia Pacific Loan Market Association (APLMA). Sustainability-Linked Loan Principles (SLLP). 2025.

[30] Hasselgren B. Risk Allocation in Public-Private Partnerships and the Regulatory Asset Base Model. OECD/International Transport Forum Discussion Paper. 2020