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NEC contracts and public investment in urban facilities: a systematic review

Contratos NEC e inversión pública en equipamientos urbanos: una revisión sistemática

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Abstract

Public investment in urban infrastructure in Peru faces challenges associated with execution delays, cost overruns, contractual disputes, and limitations in project management. In this context, this study aimed to analyze the scientific evidence on the incorporation of NEC contracts as a tool to improve the efficiency of public investment in urban facilities. To this end, a systematic literature review was conducted, following the PRISMA 2020 guidelines, using searches in Scopus, SciELO, Redalyc, Dialnet, and Google Scholar, considering publications between 2017 and 2025. After re-evaluating the selection process, 25 studies that met the established criteria were included. The results indicate that NEC contracts promote collaborative management by partners, early risk mitigation, fewer disputes, and a higher level of integration among project stakeholders. Similarly, the literature indicates that the introduction of tools such as Building Information Modeling (BIM) strengthens both the planning and control, as well as the quality of public infrastructure execution. On the other hand, challenges were identified related to adjusting the regulatory framework, training public operators, and adequately defining the collaboration principles derived from the model. Thus, this study concluded that NEC contracts represent a new alternative that could improve the management of public investments in urban facilities in Peru, but that their implementation still requires institutional strengthening and more empirical evidence at the national level.

Keywords: public investment, NEC contracts, urban facilities.

Resumen

La inversión pública en infraestructura urbana, en el Perú, enfrenta desafíos asociados con retrasos en la ejecución, sobrecostos, controversias contractuales y limitaciones en la gestión de proyectos. En este contexto, el presente estudio tuvo como objetivo analizar la evidencia científica sobre la incorporación de los contratos NEC como herramienta para mejorar la eficiencia de la inversión pública destinada a equipamientos urbanos. Para tal fin, se realizó una revisión sistemática de la literatura, siguiendo las directrices PRISMA 2020, mediante búsquedas en Scopus, SciELO, Redalyc, Dialnet y Google Scholar, considerando publicaciones entre 2017 y 2025. Tras la reevaluación del proceso de selección se incluyeron 25 estudios que cumplieron los criterios establecidos. Los resultados indican que los contratos NEC fomentan la gestión colaborativa por parte de los socios, la mitigación temprana de riesgos, una menor ocurrencia de disputas y un mayor nivel de integración entre las partes interesadas del proyecto; de manera similar, la literatura señala que la introducción de herramientas como el Building Information Modeling (BIM) refuerza tanto la planificación y el control como la calidad de la ejecución de

la infraestructura pública. Por otra parte, se reconocieron desafíos relacionados con el ajuste del marco regulatorio, la capacitación de los operadores públicos y la delimitación adecuada de los principios de colaboración derivados del modelo. Así, este estudio concluyó que los contratos NEC representan una nueva alternativa que podría mejorar la gestión de las inversiones públicas en instalaciones urbanas en el Perú, pero que su implementación aún requiere fortalecimiento institucional y más evidencia empírica a nivel nacional.

Palabras claves: inversión pública, contratos NEC, equipamientos urbanos.

Introduction

Urban infrastructure still suffers from shortcomings that make it difficult to incorporate new materials and technologies. Investment in infrastructure can nonetheless help improve the services available to the population and their overall quality of life, by expanding access to basic services such as education, health care, and recreation. That said, poor planning and badly conceived projects can lead to structural failures that undermine how cities function (Ajmal & Rajasekaran, 2023; Cheng et al., 2024; Figueroa, 2020).

Given this reality, global investment in urban infrastructure has come to be recognized as one of the key drivers of sustainable development. International bodies such as the World Bank and the United Nations have accordingly called for stronger infrastructure financing and management policies that account for both population growth and the challenges posed by climate change. Even so, many countries continue to struggle with a lack of transparent project governance and poorly organized budgetary resources, which has left financial responses falling short of these pressing demands (Cho et al., 2025; Organización de Naciones Unidas, 2018).

Throughout Latin America, planning and carrying out urban infrastructure projects remains fraught with difficulty, corruption, bureaucratic red tape, and limited citizen participation chief among them. Despite new public policies and financing models, many cities still show critical gaps in basic services and efficient urban mobility. Alternative contractual arrangements, such as NEC contracts, have emerged in this context to improve efficiency and transparency during project execution; their uptake across the region, however, remains sporadic (Molina-Quinteros et al., 2021; Moris, 2011; Villalpando-Flores, 2022).

Within the education sector, building well-equipped schools is essential to guaranteeing access to quality education, since adequate school infrastructure fosters better learning conditions and helps curb dropout rates, particularly in vulnerable communities (Aya & Giraldo, 2018). Modern facilities equipped with appropriate technology and recreational spaces likewise improve academic performance and promote social inclusion. Building libraries and community centers, moreover, can give residents ongoing opportunities for training and education, expanding their prospects for professional and personal growth (Gutiérrez Camelo et al., 2023; López & Granados, 2020).

Investment in urban transportation systems, in turn, eases residents' mobility and narrows disparities in access to jobs and education. An efficient transport system cuts commuting times, boosts productivity, and helps reduce environmental pollution. Multimodal transport networks that combine trains, buses, and bike lanes therefore make mobility more sustainable and accessible across all segments of the population, particularly for those with reduced mobility or limited financial resources (Granda et al., 2021).

Another key facet of urban infrastructure investment is its contribution to public safety and civic life. Adequate street lighting, shared public spaces, and surveillance technologies all help bring down crime and violence in cities. Well-designed spaces, in this sense, encourage social interaction, strengthen community ties, and ease the perception of insecurity. Sound urban planning can also curb the spread of informal settlements and raise the quality of life in marginalized neighborhoods (Bollo et al., 2022; Huaman, 2025).

For this investment to have a genuine impact, however, resources must be managed both efficiently and transparently. Infrastructure projects in Peru frequently run into cost overruns, execution delays, and inadequate maintenance. Oversight mechanisms and citizen participation are therefore needed to ensure that public works actually respond to the population's real needs (Iglesias & Gómez, 2021).

For its part, the use of smart management technologies, well-structured contracts, and collaboration with the private sector can all help streamline resource administration and curb corruption in project execution. There is likewise a need to encourage active involvement from the community in planning and evaluating these investments, so as to ensure that priority needs are effectively addressed (Botero & García, 2018; Posada & Gómez, 2002).

Public investment in urban infrastructure, then, stands out as a determining factor in improving society's quality of life. Its effectiveness, however, hinges, as already noted, on sound planning, efficient management, and active community involvement. Governments must therefore commit firmly to transparency and sustainability, so that every public work fulfills its social function and contributes to the well-being of the entire citizenry.

Urban infrastructure, in this light, should not be understood merely as an investment in concrete and steel, but rather as a tool for strengthening social cohesion, narrowing inequality, and building more livable and resilient cities. Properly implementing public policies geared toward inclusion and sustainability will accordingly be key to ensuring that urban growth benefits everyone, regardless of economic or social standing.

In Peru, investment in urban infrastructure has been a priority in recent years, driven by the need to close gaps in access to basic services and strengthen cities' resilience to natural hazards. The country nonetheless faces considerable challenges in governance and contract management, which have led to delays and cost overruns in public works. NEC contracts have been promoted in this context as a strategy for improving planning and reducing conflict among the parties involved, although their implementation still calls for greater efforts in training and regulatory adaptation (Príncipe, 2021; Ugarte & Porcel, 2023).

In light of the foregoing, it becomes clear that analyzing the importance of public investment in urban infrastructure, and its impact on population well-being, is essential, particularly when considering contractual models capable of fostering efficiency and transparency in project management. This study accordingly seeks to understand the relevance of public investment in creating and improving urban infrastructure such as parks, schools, and health centers, all of which are fundamental to public well-being, through the lens of NEC contracts in Peru, while highlighting the role of sustainability and citizen participation in building more inclusive and resilient cities (Cho et al., 2025; Marinho et al., 2021; Ministerio de Economía y Finanzas, 2021). The research thus aims to synthesize and analyze the scientific evidence published between 2017 and 2025 on the application of NEC contracts in public investment projects for urban facilities, identifying their principal contributions, benefits, challenges, and opportunities for implementation within the Peruvian context.

Methodology

This study followed a systematic review approach, guided by the PRISMA 2020 statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), to ensure transparency and replicability throughout the process (Page et al., 2021).

The literature search was carried out in the Scopus, SciELO, Redalyc, Dialnet, and Google Scholar databases, covering full-text, double-blind peer-reviewed publications in Spanish and English from 2017 to 2025. To this end, a term map on NEC contracts was developed, incorporating concepts such as collaborative contracting, risk management, target costing, BIM, and public infrastructure. The search strings used were as follows: ("*NEC contracts*" *OR* "*New Engineering Contract*" *OR NEC3 OR NEC4*) *AND* ("*public infrastructure*" OR "*public investment*" *OR* "*urban facilities*"); ("*NEC*" *AND* "*early warning*" *AND construction*); ("*NEC*" *AND* "*target cost*" *AND risk*); and ("*collaborative contracting*" *OR* "*relational contracting*") *AND* (*BIM OR* "*public infrastructure*").

Eligible studies also had to provide either direct evidence on NEC contracts or contextual support indispensable to understanding their relevance to public infrastructure, in areas such as collaborative contracting, BIM, risk management, sustainability, governance, or the improvement of urban facilities. Theses, technical reports, gray literature, duplicates, studies lacking sufficient methodological detail, and research with no analytical bearing on the review's objective were excluded. Selection proceeded in two stages: first through a reading of titles and abstracts, and subsequently through full-text review.

Table 1

Selection process based on the PRISMA 2020 statement guidelines

Phase	Records	Reason for exclusion
Identification	162	Records retrieved from the databases consulted
Screening	58	Excluded for duplication or thematic irrelevance in title/abstract
Eligibility	46	Full texts assessed against the criteria
Final inclusion	25	21 texts excluded for insufficient indirect relevance, lack of methodological detail, or absence of usable results

Source. Authors' own elaboration

Selecting studies published between 2017 and 2025 is justified by their theoretical and empirical contribution to this research. These works offer a balanced discussion of social participation in building urban facilities, the shift toward collaborative models in Peru, the evaluation of contractual performance and, critically, how cost overruns and the role of municipal governance have been addressed. Building on these contributions, an exhaustive systematic review was carried out, designed to respond precisely to the methodological needs identified by the researchers rather than a purely documentary analysis.

It is worth noting that the information from the included studies was organized through a data-extraction model covering author, year of publication, country, objective, methodology, key results, and contributions related to the application of NEC contracts. The evidence was then synthesized through a thematic comparison that identified the main trends, findings, limitations, and opportunities for implementing this contractual modality in investment projects tied to urban infrastructure development.

Because this research aimed to synthesize the existing scientific evidence on the use of NEC contracts, no formal risk-of-bias assessment was performed on the included articles. It was nonetheless verified that all publications were peer-reviewed scientific articles that described their scope, methodology, and results clearly enough to allow their applicability to be assessed.

The characterization and synthesis of the 25 included studies presented below, shown in Table 2, is organized according to their direct or contextual relationship with the object of study.

Table 2

Characterization, synthesis, and contribution matrix of the selected scientific evidence (2017–2025)

Source study	General objective	Methodology	Key results	Key conclusions	Contribution to this review
Yabar-Ardiles et al. (2023)	To optimize public procurement using NEC4 ECC in Peru.	Review and road-project case study.	Identifies five shortcomings of traditional procurement and opportunities for improvement.	NEC4 can strengthen collaboration and contract management.	Direct: Peruvian evidence of NEC4 application.
Ugarte & Porcel (2023)	To analyze financial risk under NEC3.	Legal-doctrinal analysis.	Delays and valuations affect liquidity and shift cost overruns onto the state.	Allocating and managing financial risk is critical.	Direct: warns of fiscal limits and risks.
Lau et al. (2019)	To identify barriers to NEC adoption.	Survey of practitioners and interviews.	Cultural resistance, limited training, and scarce case law.	Adoption requires organizational change and new competencies.	Direct: international framework of barriers.
Medina (2019)	To assess G2G agreements and NEC in Peruvian procurement.	Systematic regulatory analysis.	Less bureaucratic interference and potential for fewer disputes.	Institutional and regulatory adaptation is required.	Direct: Peruvian legal precedent.
Bayfield (2018)	To examine early warnings and collaboration under NEC.	Applied conceptual analysis.	Early warnings contain problems before they escalate.	Active risk logging is decisive.	Direct: underpins the preventive approach.
Siu et al. (2018)	To quantify risk in NEC projects.	Data modeling and analysis.	Early quantification improves cost and schedule control.	Collaboration must be grounded in rigorous data.	Direct: quantitative basis for risk management.

Yeung et al. (2023)	To develop an NEC performance index.	Expert Delphi study.	Integrates time, cost, quality, safety, risk, and trust.	KPIs support objective evaluation and benchmarking.	Direct: indicators for evaluating NEC projects.
Ajmal & Rajasekaran (2023)	To compare NEC4 ECC with FIDIC.	Comparative contract analysis.	NEC shows greater flexibility and more active change management.	Process clarity can reduce disputes.	Direct: contrast between standardized contracts.
Figueroa (2020)	To analyze risk allocation in collaborative contracts.	Comparative legal analysis.	Early, shared allocation improves responsiveness to change.	Collaboration requires clear rules and traceability.	Direct-contextual: foundation of collaborative risk-sharing.
Gutiérrez Espinoza (2023)	To examine the effects of NEC on Peruvian public infrastructure.	Analysis of experiences and cases.	Reports improvements, but also capacity and cultural gaps.	The contract does not substitute for institutional maturity.	Direct: critical evaluation of the Peruvian case.
Montoya & Brioso (2024)	To propose a management approach combining standardized contracts and BIM for PPPs.	Management model and expert validation.	Contractual-digital integration improves coordination and control.	BIM and standardized contracts are complementary.	Direct-contextual: NEC/BIM integration in Peru.
Marinho et al. (2021)	To analyze relational contracting and BIM.	Conceptual study and sector analysis.	The combination reduces information asymmetries.	Interoperability improves transparency and decision-making.	Contextual: explains the collaboration–BIM synergy.
Cheng et al. (2024)	To synthesize smart contracts and sustainable performance.	Bibliometric and content analysis.	Digitalization strengthens traceability, coordination, and sustainability.	Digital governance requires compatible contractual frameworks.	Contextual: supports contractual digital transformation.
Franco et al. (2023)	To examine sustainable, resilient, and inclusive cities.	Review and conceptual analysis.	Infrastructure must integrate resilience and a social approach.	Sustainability must be built in from the planning stage.	Contextual: criteria for urban facilities.
Iglesias Pascual & Gómez (2021)	To review the social dimension of green infrastructure.	Literature review.	Benefits depend on accessibility, equity, and governance.	Evaluation should include socio-environmental well-being.	Contextual: broadens the concept of public value.
Iborra & Ortuño (2019)	To analyze social infrastructure and urban identity.	Theoretical-applied study.	Functional and social diversity strengthens identity and cohesion.	Facilities must respond to the local context.	Contextual: facility–well-being link.

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Rezende & Marques (2023)	To examine green infrastructure in small cities.	Review and case analysis.	Green planning improves sustainability and livability.	The local scale calls for tailored solutions.	Contextual: sustainability of facilities.
Aurrekoetxea-Casaus (2018)	To critically review urban resilience.	Systematic theoretical review.	Resilience depends on adaptation and governance, not physical works alone.	Policies must integrate socio-environmental dynamics.	Contextual: conceptual foundation of resilience.
Príncipe (2021)	To assess participation and participatory budgeting in Peru.	Qualitative documentary analysis.	Project paralysis erodes citizens' trust.	Legitimacy requires linking participation to execution.	Contextual: subnational governance.
Mendoza-Hidalgo & Vegas-Meléndez (2023)	To study citizen participation in local government.	Analytical qualitative study.	Social oversight can reduce opacity and corruption.	Shared responsibility fosters the sustainability of public space.	Contextual: participation and social oversight.
Huaman (2025)	To review multilevel governance and participation.	Literature review.	Intergovernmental coordination shapes public outcomes.	Governance requires effective channels and capacities.	Contextual: institutional coordination.
Vargas (2025)	To analyze the incorporation of NEC/FIDIC in Peru.	Legal and regulatory analysis.	Identifies opportunities and tensions with the national regime.	Adoption requires compatibility rules and training.	Direct: update to Peruvian regulations.
Cho et al. (2025)	To analyze claims governance in standard-form contracts.	Comparative analysis of clauses and procedures.	Procedural clarity improves the traceability of entitlements and claims.	Contractual checklists reduce omissions and disputes.	Direct-contextual: dispute management.
Botero & García (2018)	To examine public spending and public-private partnerships.	Economic-institutional analysis.	Efficiency depends on incentive design and public oversight.	Contract structure must protect value for money.	Contextual: economic governance of investment.
Molina-Quinteros et al. (2021)	To analyze smart, sustainable cities.	Conceptual review.	Technology must align with sustainability and human needs.	Innovation requires a holistic view of the city.	Contextual: complementary urban-digital framework.

Methodological note. Fourteen studies form the direct core of NEC/standardized contracts, while 11 provide complementary contextual grounding. This distinction was preserved throughout the interpretation so as not to attribute effects stemming from BIM, governance, or sustainability to the contractual model itself / **Source.** Authors' own elaboration based on the literature reviewed

Results and discussion

Urban infrastructure stands as one of the fundamental pillars for city development and public well-being. Investing in this area, then, answers not only the need to renew and strengthen urban systems but also has a direct

bearing on citizens' quality of life. Governments can help narrow social inequality and build a more sustainable environment by creating and upgrading spaces such as parks, schools, and health facilities. Even so, it remains essential to assess whether such projects actually fulfill their purpose and whether resources are being managed appropriately (Benítez, 2023; García-Gil et al., 2020).

To avoid speculative claims, the findings from the thematic synthesis of the 25 studies were organized into two types of evidence: direct evidence on NEC contracts and complementary contextual evidence. Five emerging categories were identified on this basis: contractual performance and early risk management; costs and risk allocation; NEC-BIM integration; sustainability and public value; and governance, capacities, and citizen participation.

Table 3
Systematization matrix of findings

Analytical category	Key finding	Challenges and limitations/critiques	Citations and supporting sources
Performance and Early Risk Management	Early warnings, risk logging, and multidimensional indicators improve predictability and learning.	A lack of documentation discipline and training can reduce the process to mere formalism.	Bayfield, 2018; Lau et al., 2019; Siu et al., 2018; Yeung et al., 2023; Yabar-Ardiles et al., 2023
Costs and Risk Allocation	Target-cost schemes align incentives when the target, the defined costs, and the gain/pain share are verifiable.	Weak initial budgets, compensation events, and insufficient oversight can drive up public spending.	Ajmal & Rajasekaran, 2023; Figueroa, 2020; Ugarte & Porcel, 2023
NEC-BIM Integration	Combining collaborative contracts with BIM improves coordination, transparency, and the early detection of clashes.	Interoperability, digital accountability, and organizational maturity remain barriers.	Cheng et al., 2024; Marinho et al., 2021; Montoya & Brioso, 2024
Sustainability and Public Value	Facilities should be evaluated on accessibility, well-being, resilience, and sustainability, not just physical completion.	The contextual evidence does not allow these outcomes to be attributed to the contractual model alone.	Aurrekoetxea-Casaus, 2018; Franco et al., 2023; Iborra & Ortuño, 2019; Iglesias & Gómez, 2021
Governance and Capacities	Regulatory adaptation, training, multilevel coordination, and citizen participation all shape implementation.	Cultural resistance and institutional weakness can offset the model's advantages.	Gutiérrez Espinoza, 2023; Huaman, 2025; Medina, 2019; Mendoza-Hidalgo & Vegas-Meléndez, 2023; Príncipe, 2021; Vargas, 2025

Source. Authors' own elaboration based on the literature reviewed

The synthesis shows that NEC contracts contribute mainly through forward-looking management mechanisms, such as early warnings, decision traceability, and incentives to resolve problems before they escalate into disputes (Bayfield, 2018; Lau et al., 2019; Yabar-Ardiles et al., 2023). Quantitative studies and indicator-building work likewise indicate that performance should be measured through variables such as cost, schedule, quality, safety, risk, and trust, rather than by the mere absence of litigation (Siu et al., 2018; Yeung et al., 2023).

Investment in urban infrastructure is accordingly recognized as having a significant impact across several dimensions of social well-being. It helps improve public health by enabling the construction of accessible hospitals and health centers, allowing for more equitable and timely care. The availability of recreational spaces, such as parks and bike lanes, likewise promotes physical activity and reduces stress levels among the population. A well-planned urban environment can therefore also be understood to reduce diseases linked to environmental pollution

and inadequate sanitary infrastructure, including access to clean water and modern sewage systems (Iborra & Ortuño, 2019; Rezende & Marques, 2023).

The certainty that BIM and relational contracting bring to the table suggests that integrating the contractual and the digital can mitigate information asymmetries, flag conflicts early, and improve coordination among stakeholders (Marinho et al., 2021; Montoya & Brioso, 2024). BIM should therefore not be framed as an automatic enhancement of the NEC contract, but rather as an integrating instrument whose usefulness depends on clearly defined information flows, authorities, and competencies.

While it offers clear operational advantages, the scientific literature points to critical shortcomings in how NEC contracts have been implemented in Peru, particularly with respect to financial stability, given the rise in project costs.

One of the most significant criticisms is that, under Options C and D (Target Contract), cost risk is shared between the employer, that is, the state, and the contractor (Ugarte & Porcel, 2023). Under this scheme, if a project exceeds its initial budget due to inefficiencies or poorly managed contingencies, the state absorbs part of the overrun according to the *gain/pain share* rules. Final public spending can therefore end up higher than it would under a traditional lump-sum contract, owing to imprecise initial budgets and weak oversight of the "defined costs" (Ugarte & Porcel, 2023).

Compensation events, set out under Clause 60, are the principal mechanism behind budget increases. Although designed to distribute risk fairly, Peruvian practice has revealed several drivers of cost growth, including undetected design-scope expansions, variations in management costs, and delays in site handover (Martínez, 2023; Ugarte & Porcel, 2023). Disruption to project activities, moreover, triggers a domino effect that drives up overhead costs and undermines project liquidity (Montoya & Brioso, 2024; Ugarte & Porcel, 2023).

According to the review, the "plain language" benefit that NEC is meant to offer has not materialized in Peru, since English is not the official language, a mismatch that has bred interpretive confusion which the official Spanish translation is expected to ease (Lau et al., 2019; Yabar-Ardiles et al., 2023). Cultural resistance to the idea of "mutual trust" also persists in an industry accustomed to confrontation, which frequently leads officials to wield the contract as a punitive tool rather than treat it as a collaborative mechanism (Gutiérrez Espinoza, 2023; Vargas, 2025).

This systematic review must also be read in light of its limitations, since scientific literature specifically addressing Latin American urban facilities remains scarce. Complementary literature on collaborative contracting, BIM, governance, and sustainability was therefore included as well, though kept distinct from the conceptual core of the NEC contract. Methodological heterogeneity ruled out a meta-analysis and called for caution when comparing findings. The study was likewise confined to references published in Spanish and English and to the databases consulted. That said, the use of PRISMA 2020, peer review, and the stratification of the literature strengthened the transparency, traceability, and coherence of the synthesis.

Conclusions

This study holds that public investment in urban infrastructure in Peru can achieve a better cost-value ratio when it turns toward collaborative models, offering an alternative to the paralysis so often seen in public works. Along these lines, the systematic review carried out under the PRISMA standard showed that alternative delivery methods, such as NEC contracts, provide more effective management tools than traditional procurement systems, yielding significant benefits in terms of transparency and schedule compliance.

That said, the study also finds that NEC is no automatic fix for cost overruns. Target-cost contracts are flexible, but they demand technical and financial discipline throughout the life of the contract and even after execution is complete. The Peruvian state should accordingly adopt broader measures rather than treat this contract type as a residual option. Local governments, for their part, must not only throw their firm support behind this contractual model but also strengthen their oversight capacity to keep compensation events from ballooning into budget inflation.

How well public investment performs at the national level hinges on its capacity to properly align private-sector incentives with social welfare, in other words, to deliver functional urban facilities for every sol invested. The findings of this review show that the literature converges on three conditions essential to the effective implementation of NEC contracts in Peru: specialized institutional capacity, early risk management, and contractual integration with digital tools such as BIM. Direct evidence supports improvements in collaboration, predictability, and reduced disputes, while contextual evidence indicates that these benefits hinge on governance, transparency, and stakeholder participation. Comparative empirical studies of Peruvian projects are therefore needed, assessed through consistent indicators such as schedule, cost, quality, disputes, and public value.

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