SCIENTIFIC CULTURE

www.sci-cult.com

SCIENTIFIC CULTURE, Vol. 11, No. 4, (2025), pp. 3707-3719
Open Access. Online & Print

DOI: 10.5281/zenodo.21141413

ENHANCING THE SUSTAINABILITY OF PERFORMANCE-BASED ROAD CONTRACTS: A SYSTEMATIC REVIEW OF CRITICAL SUCCESS FACTORS

Castro Elorm Nyoagbe[1*] and Harry Evdorides[2]

[1]University of Birmingham, School of Civil Engineering, Edgbaston, Birmingham, UK, Department of Feeder Roads, Ghana Email: cen861@student.bham.ac.uk, elormnyoagbe@icloud.com, elormnyoagbe@gmail.com.
[2]University of Birmingham, School of Civil Engineering, Edgbaston, Birmingham, UK

Received: 01/11/2025
Accepted: 26/11/2025

Corresponding Author: Castro Elorm Nyoagbe (cen861@student.bham.ac.uk)

ABSTRACT

Performance-Based Road Contracts (PBRCs) are widely promoted to address inefficiencies in traditional road management approaches. However, successful PBRC implementation remains a challenge, especially in developing countries. This study systematically reviews the evidence on critical success factors (CSFs) that contribute to effective PBRC implementation and performance. A systematic review was conducted in line with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. Literature was sourced from Scopus and Web of Science (WoS) from 1980 to 2024. A total of 15 peer-reviewed articles were selected based on predefined eligibility criteria using a Population, Intervention, Comparator, Outcome (PICO-based) approach. Thematic analysis was employed to synthesize data. Three primary groups of CSFs emerged: (1) governance, economic and financial, institutional and industry readiness factors; (2) environmental, social and risk control factors and (3) technical, procurement and performance factors. These factors are interdependent and context-sensitive. Lack of baseline data, weak stakeholder coordination, and inappropriate risk-sharing models were identified as recurring barriers. The study concludes that the success of PBRCs depend on a coordinated approach that integrates the governance, economic and financial, industry readiness, environmental, social, risk control, project design, procurement and performance considerations. Thus, practitioners and policymakers should ensure adequate capacity, baseline data, and a suitable contractual environment. Further empirical research is needed to validate CSFs in diverse national contexts.

KEYWORDS: Sustainable Development Goals, Performance-Based Contracting, Critical Success Factors, Infrastructure, PRISMA, Road Asset Management, Systematic Review.

1. INTRODUCTION

The quality and reliability of road infrastructure play a pivotal role in economic growth, regional integration, and social development. In many countries, particularly in the Global South, the road network constitutes the backbone of transportation systems, facilitating the movement of goods, services, and people (Bawole & Sutano, 2025; Mulmi, 2016; Sichoonqwe, 2025; Stankevich et al., 2005; Wirahadikusumah et al., 2015; Zietlow, 2016). However, the traditional approaches to road maintenance and rehabilitation—characterized by input-based contracts and fragmented project delivery—have often failed to sustain desired road conditions, resulting in significant economic losses, service interruptions, and inefficient public spending (Bull et al., 2014; Gajurel, 2014; Osei et al., 2024; Stankevich et al., 2005; Sultana et al., 2012; Xu et al., 2024).

In response to these challenges, Performance-Based Road Contracting (PBRC) has emerged as a strategic solution. Unlike conventional methods that remunerate contractors based on activities performed (e.g., patching potholes or resurfacing), PBRC shifts the focus toward service delivery by tying contractor payments to predefined performance outcomes such as ride quality, safety, and road condition indices (Asian Development Bank [ADB], 2018; Alsharqawi et al., 2017, Cao et al., 2024; Gericke et al., 2014; Zhao et al., 2024). Under this model, contractors assume greater responsibility for both routine and periodic maintenance, often over extended timeframes (5–10 years), thereby promoting cost-efficiency, innovation, and risk-sharing.

Despite the conceptual advantages of PBRC—such as predictable maintenance budgets, improved accountability, and life-cycle cost optimization—implementation outcomes vary widely across countries. While success has been reported in countries like Brazil, Chile, and New Zealand (Bull et al., 2014; Clahorra-Jimenez & Poythress, 2024; Stankevich et al., 2005; Wirahadikusuma et al., 2015; Zietlow, 2016) others have encountered difficulties stemming from inadequate legal frameworks, poor baseline data, limited stakeholder capacity, and weak monitoring mechanisms (Abreu et al., 2024; Abusamra, 2018; Gupta et al., 2011; Hughes & Kabiri, 2013; Sultana et al., 2012). These recurring implementation challenges underscore the limitations of traditional contracting environments, which are often ill-equipped to manage the complexities of output-based or hybrid performance contracts.

Several studies have examined PBRC in specific national or regional contexts, focusing on issues such as performance indicators (Bardhi, 2024; Calahorra-Jimenez & Poythress, 2024), cost efficiency (Bahrudin et al., 2025; Zhu et al., 2025), and institutional readiness (Abate et al., 2025; Zhu et al., 2025). However, there remains a notable gap in the literature: few studies have synthesized cross-country experiences to identify common factors that contribute to PBRC success (Abusamra, 2018; ADB, 2018; Alsharqawi et al., 2017; Brunella, 2018; Bull et al., 2014; Gajurel, 2014; Gericke et al., 2014; Gupta et al., 2011; Hughes & Kabiri, 2013; Molenaar & Navarro, 2011; Mulmi, 2016; Stankevich et al., 2005; Sultana et al., 2012; Wirahadikusumah et al., 2015; Zietlow, 2016). Without a consolidated evidence base, governments and donor agencies lack a structured understanding of what conditions must be met for PBRCs to achieve their intended objectives—particularly in low- and middle-income countries.

This systematic review aims to address that gap by identifying and synthesizing peer-reviewed literature on critical success factors (CSFs) for PBRC implementation. Drawing from empirical studies published between 1980 and 2024, the review adopts a structured PICO-based eligibility framework and follows PRISMA 2020 guidelines to ensure methodological rigor. Also, the overarching research objective is: To identify and synthesize evidence on critical success factors (CSFs) that contribute to the success of Performance-Based Contracts in road asset management. This objective is framed by the central research question: What is the evidence of factors that account for the success of a Performance-Based Contract in the management of road assets? By addressing this question, the review seeks to inform policymakers, practitioners, and researchers about the enabling conditions necessary for effective PBRC implementation. It also offers practical insights for contract design, institutional reform, and stakeholder engagement in diverse contexts.

1.1. Practical Application

Roads function as vital infrastructure for economic development and daily transportation but numerous nations face difficulties in maintaining their road networks properly. Traditional road maintenance contracts fail to deliver reliable results which leads to poor service quality, higher costs and avoidable public financial losses. This study reviewed global evidence on what makes Performance-Based Road Contracts (PBRCs) succeed. The payment system of PBRCs functions autonomously from standard payment systems because it bases provider compensation on performance and road condition assessment, which results in better service quality and increased accountability.

The review exposed key factors which produce successful results. The success of public-private partnership (PPP) projects depends on three essential sets of factors. These factors include (1) governance,

economic and financial, institutional and industry readiness factors; (2) environmental, social and risk control factors and (3) technical, procurement and performance factors.

The research indicates that governments need to join technical solutions with supportive policies and institutional capacity development to achieve their goals. The practical implementation of these recommendations requires agencies to develop their skills and make timely payments, while using digital monitoring systems and building community trust through public engagement. The identified success factors help countries build roads that last longer while being safer and cheaper to maintain, leading to better development outcomes and higher quality of life.

2. METHODS

This systematic review was conducted in accordance with the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure methodological rigor and transparency. The methodology encompassed a structured protocol, a PICO-based inclusion framework, and a multi-step literature selection and analysis process.

2.1. Review Protocol

A review protocol was developed prior to initiating the search process. It defined the objectives, eligibility criteria, search strategy, data extraction procedures, and synthesis approach. Although the protocol was not prospectively registered in a public repository, all review steps were executed as planned and documented. Adherence to PRISMA 2020 standards was maintained throughout.

2.2. Eligibility Criteria

Eligibility was defined using a PICO (Population, Intervention, Comparator, Outcome) framework as presented in Table 1.

Table 1: PICO Framework.

Component	Criteria
Population	Public road agencies, contractors, donors, and consultants involved in national or trunk road asset management
Intervention	Performance-Based Road Maintenance or Rehabilitation Contracts (PBRCs)
Comparator	Traditional input-based contracting or hybrid models
Outcome	Identification and synthesis of factors contributing to successful PBRC implementation

Inclusion Criteria:

- Peer-reviewed articles published between 1980 and 2024
- Studies written in English
- Studies explicitly focusing on PBRC implementation for national, trunk or feeder roads
- Empirical or conceptual papers that identify Critical Success Factors (CSFs) for PBRCs
- Studies involving public sector participation or oversight

Exclusion Criteria:

- Studies focused solely on pavement materials, construction technology, or mechanical performance
- Projects involving private road infrastructure without public sector involvement
- Grey literature (e.g., dissertations, unpublished reports, policy briefs)
- Non-English language studies
- Newspaper articles, editorials and any form of popular media.

2.3. Information Sources and Search Strategy

A comprehensive search was performed using two major academic databases: Scopus and Web of Science (Core Collection). The search included publications from 1980 to 2024, covering a period aligned with the emergence and institutionalization of PBRCs globally. Search strategy employed Boolean operators and keyword combinations such as: (performance-based contract OR PBMC OR PBRC) AND (road OR highway) AND (success factor OR implementation OR management OR critical factors). Search filters were applied to restrict results to English-language publications and Peer-reviewed journal articles. In addition to database queries, manual searches of the bibliographies of key articles were conducted to identify studies not captured through the electronic search. Reference chaining was used to identify influential or frequently cited works.

2.4. Study Selection Process

The study selection process followed a two-stage screening approach:

1. Title and abstract screening to assess preliminary relevance
2. Full-text screening for eligibility and content alignment

Duplicate records were removed using the EPPI-Reviewer Web platform. The selection process is illustrated in the PRISMA 2020 Flow Diagram, which

outlines the number of records retrieved, screened, excluded, and included.

2.5. Data Extraction and Management

A structured data extraction template was developed and applied within EPPI-Reviewer Web. Extracted variables included: Author(s) and year of publication, country or region of study, contract type and road classification, identified Critical Success Factors (CSFs), stakeholder roles (government, contractor, donor, consultant), and reported outcomes or performance metrics. Where necessary, thematic coding was applied to harmonize terminology across studies (e.g., grouping "institutional capacity" and "human resource skills" under a single factor).

2.6. Quality Assessment

Although the primary aim was narrative synthesis, basic quality assessment criteria were applied to ensure relevance and rigor. These included: Clarity of study objectives, transparency of methodology, credibility of data sources, and direct relevance to PBRC implementation. Due to the heterogeneity of study designs (case studies, conceptual frameworks, empirical analyses), formal appraisal tools (Risk of Bias in Systematic Reviews [ROBIS] or A Measurement Tool to Assess Systematic Reviews, Version 2 [AMSTAR 2]) were not applied.

2.7. Data Synthesis

A narrative synthesis approach was employed. Critical Success Factors (CSFs) were categorized into three overarching thematic clusters based on content and context:

- Group A: governance, economic and financial, institutional and industry readiness factors;
- Group B: environmental, social and risk control factors and
- Group C: technical, procurement and performance factors

Each CSF was counted and mapped across the included studies to assess prevalence and thematic prominence. Where applicable, supportive examples from national case studies were provided to contextualize the CSFs. Visualizations such as heatmaps in Tables 2, 3 and 4, frequencies and summary matrices were generated to enhance interpretability of findings.

The data in Table 2 shows that New Zealand maintains the highest and most stable governance and industry readiness performance for all CSFs. The two countries, Chile and Kenya, show high readiness levels. They possess strong institutional capacity and complete legal frameworks and experienced private sector professionals. Brazil maintains average readiness through its specific strong points yet Uganda and India demonstrate weak preparedness because they struggle with technology implementation and reliable data and organized training programmes. The research results demonstrate that governance strength together with institutional capability and data systems create the main distinctions which separate different nations from each other.

Table 2: Governance, Economic and Financial, Institutional and Industry Readiness Heatmap of Csfs by Country.

CSF \ Country	Brazil	Uganda	India	Kenya	Chile	New Zealand
Policy and Legal Framework	□□	□	□	□□	□□	□□□
Political and Executive Support	□	□□		□□	□□	□□□
Economic and Financial Feasibility	□□	□□	□	□□	□□	□□
Road Agency Institutional Buy-In and Change Management	□□	□	□	□□	□□	□□□
Road Asset Management Knowledge and Systems	□□	□	□	□□	□□	□□□
Reliable Dataset	□□	□	□	□□	□□	□□□
Appropriate Technology	□		□	□□	□□	□□□
Training, Capacity Building and Market Sounding Schemes				□	□	□
Capacity and Competence of Road Agencies	□□	□	□	□□	□□□	□
Expertise and Capacity of the Private Sector	□□	□	□	□□	□□	□□□

Table 3 shows that New Zealand and Chile demonstrate the strongest and most consistent performance in environmental, safety, and risk control factors. The traffic enforcement system of Brazil shows successful risk management but its social control systems and public information platforms require improvement. The assessment shows Kenya maintains average performance levels in all assessment criteria but Uganda and India demonstrate poor and inconsistent capacity in their public information systems and their approaches to safety and environmental protection. Risk management stands as the most developed factor which countries have implemented while public

information and grievance management systems show the lowest level of development.

Table 3: Environmental, Social and Risk Control Heatmap of Csfs by Country.

CSF \ Country	Brazil	Uganda	India	Kenya	Chile	New Zealand
Environmental and Social Stewardship and Management	□			□	□	□
Consideration for Safety	□	□		□	□□	□□
Risk Management	□□□	□□	□	□□	□□	□□□
Traffic Management and Enforcement of Axle Load Limits	□□	□		□□	□□	□
Public Information and Grievance Management				□	□	

The data in Table 4 shows that New Zealand maintains the highest procurement and performance capabilities for all CSFs while Chile and Kenya follow with their best results in monitoring and performance indicator and payment mechanism management. The monitoring system and incentive programmes, and payment structures in Brazil operate at a high level yet the country faces challenges with its procurement system and dispute resolution process. The project design and procurement processes of Uganda and India show lower capacity levels which are not evenly distributed. The research shows that performance-based incentive systems with monitoring functions represent the most advanced procurement elements which countries have developed.

Table 4: Procurement and Performance Heatmap of Csfs by Country.

CSF \ Country	Brazil	Uganda	India	Kenya	Chile	New Zealand
Project Design and Duration	□□	□		□□	□□	□□
Performance Indicators and Levels of Service	□□□	□□	□□	□□	□□	□□□
Procurement, Contract Negotiation and Dispute Resolution Mechanisms	□□	□		□	□□	□□
Payment Model and Cashflow	□□□	□	□	□□	□□	□□□
Effective Monitoring	□□□	□□	□□	□□□	□□□	□□□
Incentive and Penalty Systems	□□□	□□	□	□□	□□	□□□

2.8. Prisma Flow Diagram

A full PRISMA 2020 Flow Diagram is presented in Figure 1, detailing: Initial records identified, duplicates removed, records screened (title/abstract), full texts assessed, and final studies included (n=15). The diagram offers a transparent overview of the review's filtering and inclusion process.

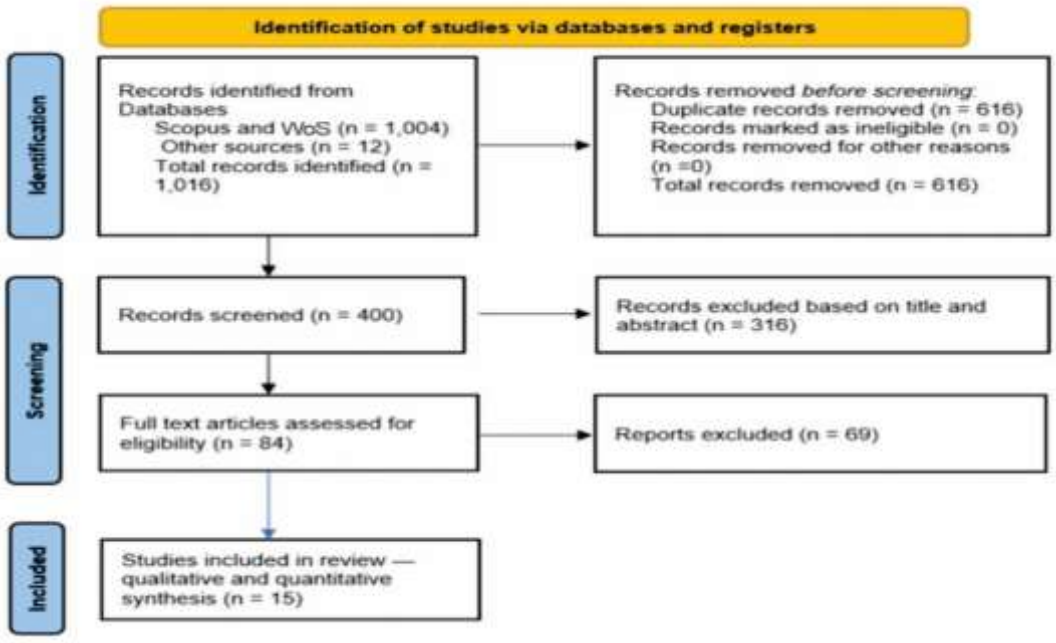

Fig. 1: PRISMA Flow Diagram.

3. RESULTS

3.1. Study Characteristics

A total of 15 peer-reviewed studies were included in this review. The studies were conducted across 13 countries, covering both high-income and low- to middle-income contexts. The geographic distribution, contract types, and stakeholder environments varied considerably, offering a broad cross-section of experiences with Performance-Based Road Contracting (PBRC). Geographic Coverage included studies covered in Africa: Uganda, Kenya, Zambia; Asia: India, Bangladesh; Latin America: Brazil, Chile, Argentina; North America: United States; Oceania: New Zealand; and Europe: United Kingdom, Estonia. Contract types were performance-based maintenance contracts (PBMCs), performance-based rehabilitation contracts, and hybrid contracts with output and Performance components. Also, stakeholders included public road agencies, private contractors and consultants, international donors (World Bank, ADB, Department for International Development [DFID]), and local communities and end users.

3.2. Critical Success Factors (Csfs)

The analysis identified and thematically grouped 21 distinct CSFs consistently associated with successful PBRC implementation. These are categorized under the three main domains:

A. Governance, Economic and Financial, Institutional and Industry Readiness Factors:

1. Policy and Legal Frameworks: Success is more likely, where enabling legislation or clear policy guidelines for PBRCs exist. These frameworks define institutional responsibilities and contract enforcement mechanisms.
2. Political and Executive Support: High-level political buy-in, including support from ministries and top agency leadership, was shown to be a prerequisite for implementation and scaling.
3. Economic and Financial Feasibility: Projects with long-term financial planning, predictable funding streams, and clear cost-benefit analyses tended to achieve better outcomes.
4. Road Agency Buy-In: Internal acceptance and ownership of PBRCs within the implementing agency influenced contract sustainability and compliance monitoring.
5. Road Asset Management Knowledge and Systems: The institutional expertise and technical tools required to plan, monitor, and optimize the lifecycle performance of road networks, including data-driven decision-making, maintenance planning, and performance tracking
6. Reliable Baseline Datasets: The availability of up-to-date road condition, traffic, and asset inventory data was foundational for contract scoping, risk allocation, and performance measurement.
7. Appropriate Technology and Innovation: Successful PBRCs incorporated digital monitoring systems, Geographic Information Systems (GIS), and mobile reporting tools to track key performance indicators (KPIs).
8. Training, Capacity Building and Market Sounding Schemes: The existence of structured training, knowledge transfer, and institutional reforms positively correlated with improved contract management and stakeholder coordination.
9. Capacity and Competence of the Public Sector: The ability of government road agencies to effectively plan, procure, manage, and oversee PBRCs through adequate technical expertise, institutional systems, and resource allocation.
10. Expertise and Capacity of the Private Sector: Capacity imbalances between government agencies and private contractors (especially in low-income settings) were commonly cited as barriers. Successful projects involved robust technical assistance and training programs.

B. Environmental, Social and Risk Control Factors:

1. Environmental and Social Stewardship and Management: Projects that explicitly incorporated environmental, climate resilience and social indicators in performance specifications were rated higher in public value.
2. Consideration for Safety: Projects that explicitly incorporated road safety elements indicators in performance specifications were also rated higher in public value.
3. Risk Management: Fair and clearly defined risk-sharing mechanisms (e.g., for weather events or material prices) contributed to smoother project execution and fewer disputes.
4. Traffic Management including Effective Enforcement of Axle Load Limits: The strategies and regulatory measures implemented to ensure smooth traffic flow and prevent road deterioration by controlling vehicle overloading through monitoring, weigh stations, and strict compliance

mechanisms.

5. Public Information and Grievance Management: Contracts that mandated public information campaigns, signage, and grievance redress mechanisms helped build community trust and responsiveness.

C. Technical, Procurement and Performance Factors:

1. Project Design and Duration: Contracts that were appropriately scaled (in terms of road length, duration, and scope) were more manageable, particularly during early adoption phases.
2. Performance Indicators and Levels of Service: Contracts that included well-defined, measurable KPIs aligned with user expectations and service levels (e.g., ride quality, response time) experienced better compliance and outcomes.
3. Procurement and Dispute Resolution Mechanisms: Transparent, competitive procurement processes and effective mechanisms for resolving disputes were recurrent themes in high-performing PBRCs.
4. Partnering, Communication, and Monitoring: Open communication channels among all stakeholders—including contractors, agencies, and donors—were cited as a major determinant of project success.
5. Payment Models and Cash Flow: Predictable and timely disbursement of payments, along with performance incentives and deductions, were integral to maintaining service levels and contractor motivation.
6. Incentive and Penalty System: The contractual mechanism in PBRCs that motivates contractors to achieve or exceed performance standards through rewards while enforcing accountability for underperformance through financial or contractual penalties.

3.3. Frequency And Strength of Evidence

The frequency with which each CSF appeared across the 15 included studies was recorded to gauge the relative prominence of each factor. The results are summarized in Table 5, Table 6 and Table 7.

Table 5: Governance, Economic & Financial, Institutional and Industry Readiness Factors (N = 15)

CSF	Frequency	% of Studies
Road Asset Management Knowledge and Systems	10	67
Reliable Dataset	10	67
Expertise and Capacity of the Private Sector	9	60
Economic and Financial Feasibility	8	53
Road Agency Institutional Buy-In and Change Management	8	53
Policy and Legal Framework	7	47
Political and Executive Support	7	47
Capacity and Competence of the Road Agency	5	33
Appropriate Technology	4	27
Training, Capacity Building and Market Sounding	1	7

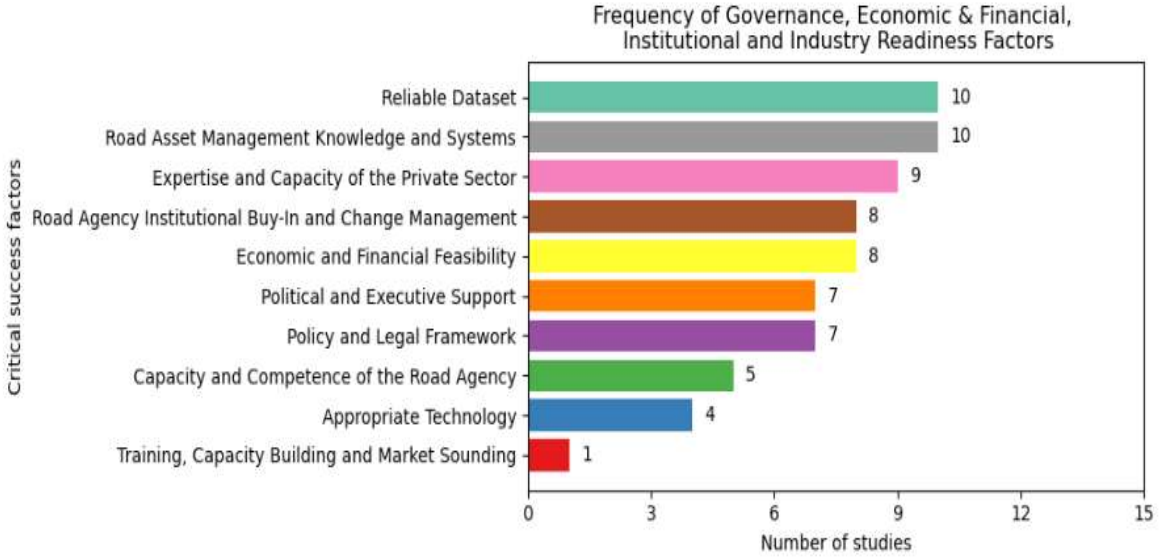

Figure 2: Frequency of Governance, Economic & Financial, Institutional and Industry Readiness Factors.

Table 5 and Figure 2 indicate that governance, economic & financial, institutional and industry readiness factors in the literature is most strongly emphasized through road asset management systems and reliable datasets, each cited in 67% of studies. There appears prominence in private sector expertise together with economic & financial feasibility assessments, serving as essential factors for achieving project success. Technology adoption and road agency capacity, and training and market sounding schemes seem less emphasised than other areas, indicating ongoing institutional and capability challenges in both practice and research.

Table 6: Environmental, Social and Risk Control Factors (N = 15).

CSF	Frequency	% of Studies
Risk Management	12	80%
Traffic Management / Axle Load Enforcement	4	27%
Consideration for Safety	3	20%
Public Information and Grievance Management	2	13%
Environmental and Social Stewardship and Management	2	13%

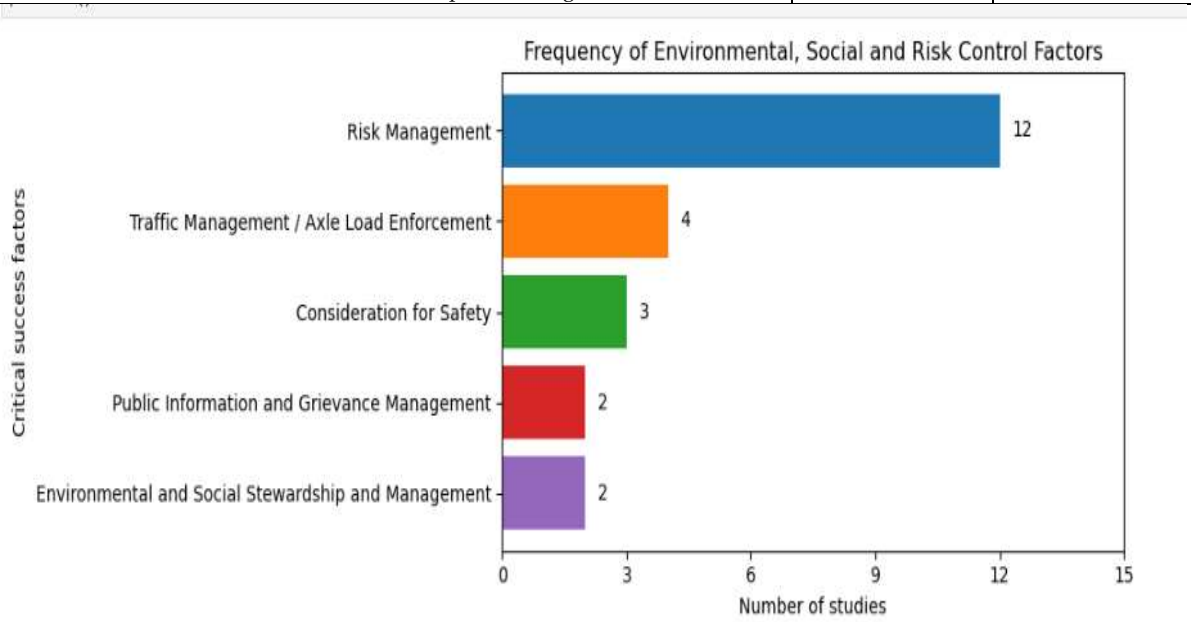

Figure 3: Percentages of Environmental, Social and Risk Control Factors.

The research findings in Table 6 and Figure 3 indicate that risk management stands as the primary environmental, social and risk control factors because it appears in 80% of the 15 studies (12 out of 15). The research demonstrates that risk management serves as a fundamental control mechanism for handling uncertainty while ensuring contract performance. The research includes four studies (27%) which focus on traffic management and axle load enforcement but safety considerations are present in three studies (20%). Public information and grievance management and environmental and social stewardship receive the least attention, each cited in just 2 studies (13%).

Table 7: Technical, Procurement and Performance Factors (N = 15).

CSF	Frequency	% of Studies
Effective Monitoring, Communication and Partnering	15	100%
Performance Indicators and Levels of Service	14	93%
Incentive and Penalty Systems	10	67%
Project Design and Duration	8	53%
Payment Model and Cashflow Management	7	47%
Procurement and Dispute Resolution Mechanisms	5	33%

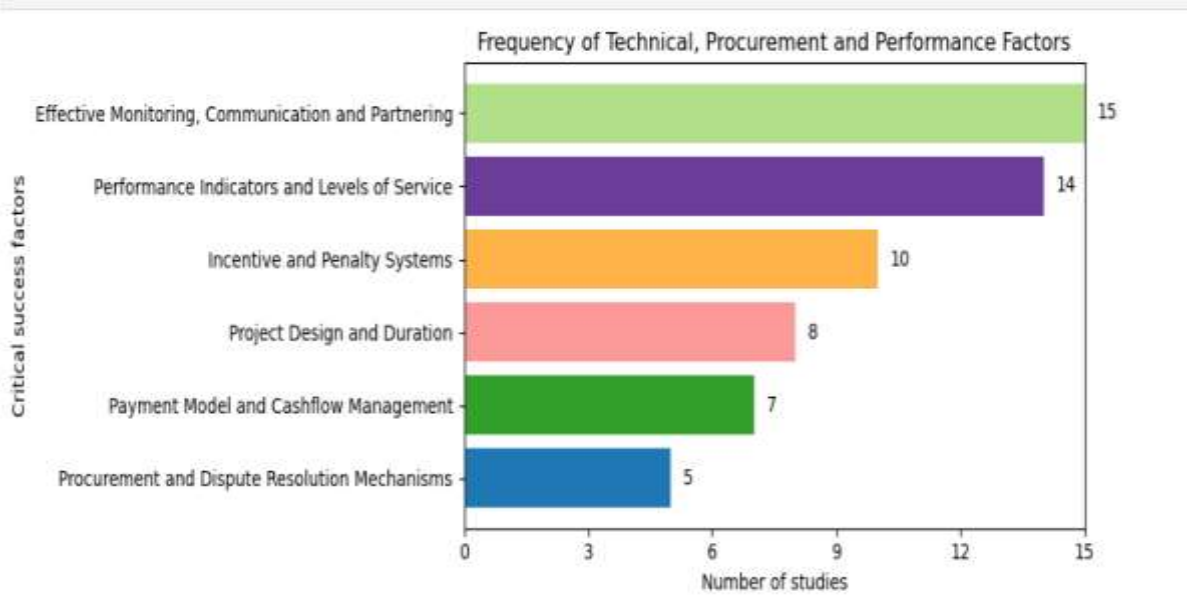

Figure 4: Percentage of Technical, Procurement and Performance Factors.

Table 7 and Figure 4 indicate that effective monitoring, communication, and partnering are universally emphasized, appearing in all 15 studies (100%), highlighting their foundational role in procurement and performance outcomes. Performance indicators and levels of service are also strongly represented, cited in 14 studies (93%), reinforcing the centrality of measurable performance frameworks. In contrast, incentive and penalty systems appear in 10 studies (67%), while project design, payment mechanisms, and especially procurement and dispute resolution mechanisms receive progressively less attention, with the latter addressed in only 5 studies (33%). Overall, the literature prioritizes monitoring and performance measurement over contractual and financial design mechanisms.

4. DISCUSSION

4.1. Summary of Key Findings

This systematic review synthesized findings from 15 peer-reviewed studies published between 1980 and 2024 to identify critical success factors (CSFs) associated with effective implementation of Performance-Based Road Contracts (PBRCs). The analysis revealed three broad thematic groups of CSFs: (1) governance, economic and financial, institutional and industry readiness factors; (2) environmental, social and risk control factors and (3) technical, procurement and performance factors.

Among these, the most frequently cited CSFs were:

- Effective Monitoring, Communication & Partnering – cited in 100% of the studies (15 out of 15).
- Performance Indicators & Levels of Service – cited in 93% of the studies (14 out of 15).
- Risk Management – cited in 80% of the studies (12 out of 15).
- Reliable Dataset / Asset Inventory and Incentive and Penalty Systems – each cited in 67% of the studies (10 out of 15).

These findings are consistent with prior research emphasizing that PBRC success hinges not only on contractual design but also on broader institutional readiness and operational coordination (Gustriansyah et al., 2025; Zhu et al., 2025). For instance, Uwibambe and Njenga (2025) highlighted that KPIs are only effective when supported by strong monitoring systems and stakeholder collaboration. Similarly, Hung et al. (2024) and Omokhoa et al. (2025) noted that institutional restructuring and staff training are often necessary to enable road agencies to transition from traditional contracting models.

Notably, this review reinforces observations from Latin American and Southeast Asian implementations, where well-defined KPIs, performance monitoring, and political support led to sustained improvements in road quality and cost efficiency (Bull et al., 2014; Molenaar & Navarro, 2011; Stankevich et al., 2005; Wirahadikusumah et al., 2015; Zietlow, 2016). Conversely, the review also confirms challenges documented in low-income countries, where PBRC outcomes were compromised due to insufficient baseline data, contractor inexperience, and delayed payments (Abusamra,

2018; Bull et al., 2014; Stankevich et al., 2005; Sultana et al., 2012).

4.2. Implications

For Policymakers:

The findings underscore the need for governments to adopt a holistic, cross-sectoral approach when institutionalizing PBRCs. At the policy level, enabling legislation should clearly delineate roles, responsibilities, and enforcement mechanisms. National strategies must also ensure financial predictability, including multi-year maintenance budgets and donor harmonization (Алексеев, 2024). Moreover, agencies should institutionalize grievance redress mechanisms and public communication channels to enhance transparency and accountability.

For Practitioners:

Contract managers, engineers, and contractors must translate CSFs into operational practices. This includes developing comprehensive contract scopes, integrating digital performance monitoring tools, and investing in risk management training. Partnering workshops between contractors and government agencies can foster mutual understanding of KPIs and enforcement procedures (Латаев, 2024). Contractors also need to be equipped with cash flow forecasting tools and performance-based costing models to improve service delivery under performance risk conditions.

For Developing Economies:

For low- and middle-income countries, the review highlights a pressing need for capacity-building at both institutional and private sector levels. Many failures in PBRC implementation stem from under-resourced road agencies, a shortage of experienced contractors, and limited technical knowledge of performance-based frameworks (Calahorra-Jimenez & Poythress, 2024). National governments and donor partners must prioritize training programs, pilot initiatives, and data management systems. South–South knowledge exchanges may also support experience-sharing among countries with similar institutional profiles (Bardhi, 2024).

4.3. Strengths And Limitations

Strengths:

This review is strengthened by its comprehensive scope, systematic protocol, and rigorous adherence to PRISMA 2020 standards. The use of a PICO-based eligibility framework enabled precise filtering of relevant literature, and the dual thematic synthesis allowed nuanced understanding of institutional and technical CSFs. By focusing exclusively on peer-reviewed studies from Scopus and Web of Science, the review prioritized methodological reliability and cross-contextual comparability.

Limitations:

However, the review has several limitations. First, publication bias may have influenced the results, as studies reporting successful PBRC implementations are more likely to be published. Second, the exclusion of grey literature, such as government reports, donor evaluations, and unpublished field studies, may have omitted valuable experiential insights—especially from developing countries where academic output on PBRCs is limited. Third, due to the heterogeneity of the included studies and the descriptive nature of most data, a quantitative meta-analysis was not feasible. Thus, the findings represent qualitative trends rather than statistically validated relationships.

5. CONCLUSION

This systematic review identified and synthesized the critical success factors (CSFs) that influence the successful implementation of Performance-Based Road Contracts (PBRCs). Based on 15 peer-reviewed studies across diverse geographic and institutional contexts, the review categorized CSFs into three broad domains: (1) governance, economic and financial, institutional and industry readiness factors; (2) environmental, social and risk control factors and (3) technical, procurement and performance factors. The most frequently cited CSFs included robust monitoring systems, clearly defined performance indicators, institutional and contractor capacity, balanced risk allocation, and reliable payment mechanisms. These findings reinforce the view that PBRC effectiveness depends not only on contractual design but also on a broader enabling environment—including policy frameworks, organizational readiness, and stakeholder collaboration. A holistic approach to PBRC implementation is therefore essential. Successful outcomes require the alignment of policy, institutional structures, financial systems, and operational processes. Isolated reforms—such as introducing performance indicators without capacity-building or legal support—are unlikely to deliver sustainable results.

5.1. Recommendations

5.1.1. Future Practice

1. Governments and road agencies should institutionalize PBRCs through legal mandates, performance-based budgeting, and inter-agency coordination mechanisms.
2. Practitioners and contractors must adopt

performance-monitoring technologies, invest in risk management skills, and foster collaborative relationships with implementing agencies.

3. Donors and international partners should support capacity development, especially in low-income countries, through pilot programmes, technical assistance, and knowledge-sharing platforms.

Future Research: Future studies should:

1. Conduct longitudinal analyses of PBRC outcomes to assess sustainability over time.
2. Explore quantitative relationships between CSFs and measurable contract outcomes, using meta-analytical or econometric techniques.
3. Investigate context-specific barriers to implementation in fragile or post-conflict states where PBRCs are gaining traction.
4. In conclusion, PBRCs hold significant promise for improving road asset management globally. However, their success is conditional on a convergence of institutional readiness, technical robustness, and stakeholder alignment. Strategic investment in these areas will be critical to realizing the full potential of performance-based infrastructure contracting.

REFERENCES

Abate, M. S., Evangelista, A. C. J., & Tam, V. W. Y. (2025). Global Research Trends in Performance-Based Structural Design: A Comprehensive Bibliometric Analysis. *Buildings*, *15*(3), 363. https://doi.org/10.3390/buildings15030363

Abreu, C. B. S. de, Braunert, M. B., Wanzinack, C., & Gil, M. (2024). Challenges to the Implementation of the new public procurement law in municipal management: the case of Pontal do Paraná. *Caderno Pedagógico*, *21*(12), e10617. https://doi.org/10.54033/cadpedv21n12-126

Abusamra, S. (2018) Coordination and Multi-Objective Optimization Framework for Managing Municipal Infrastructure Under Performance-Based Contracts. PhD thesis, Concordia University. https://spectrum.library.concordia.ca/id/eprint/985084/.

ADB (2018) *Guide to Performance-Based Road Maintenance Contracts*. Asian Development Bank, Manila, Philippines.

Alsharqawi M, Dabous SA, and Zayed T (2017) *Performance-Based Contracting for Maintaining Transportation Assets with Emphasis on Bridges*. In *MATEC Web of Conferences* (Vol. 120, p. 08012). https://doi.org/10.1051/matecconf/201712008012

Bahrudin, Moh., Patriadi, A., & Sajiyo, S. (2025). Performance Evaluation of Time and Cost In the Bungur-Kedoyo Tulungagung Road Construction Project Using the Earned Value Method. *Devotion*, *6*(1), 43–57. https://doi.org/10.59188/devotion.v6i1.25402

Bardhi, D. (2024). Performance-based road rehabilitation and maintenance contracts in Albania, a review of fifteen years of experience (2008 – 2023). *Road and Rail Infrastructure*, *8*, 759–766. https://doi.org/10.5592/co/cetra.2024.1717Bawole, P., & Sutanto, H. B. (2025). Meeting Sustainable Development Goals Through Infrastructure Development to Stimulate Economic Growth in Kampong Settlements. *Journal of Lifestyle and SDGs Review*, *5*(1), e04315. https://doi.org/10.47172/2965-730x.sdgsreview.v5.n01.pe04315

Brunella C (2018) *NDT Application in Transport Asset Management. QA/QC Performance Specifications in Pavement Construction and Maintenance - PhD Dissertation*. University of Catania, Catania, Italy. Retrieved from https://www.iris.unict.it/handle/20.500.11769/582290?utm_source

Bull, M., Brekelmans, R., & Wilson, L. (2014). *Lessons Learned in Output and Performance-Based Road Maintenance Contracts*. Public-Private Infrastructure Advisory Facility, Washington DC, USA. Retrieved from https://ppp.worldbank.org/public-private-partnership/sites/default/files/2022-06/Lesson-learned-performance-based-road_0.pdf

Calahorra-Jimenez, M., & Poythress, R. (2024). *Exploring Performance-Based Contracts: A Good Option to Address Long-Term Road Maintenance in California?* https://doi.org/10.31979/mti.2024.2359

Cao, D., Li, L., Shao, S., & Mahamoudou, F. (2024). Multi-objective optimisation for urban road network maintenance based on spatial design network analysis: trade-offs in performance, environmental impacts and costs. *International Journal of Pavement Engineering*, *25*(1). https://doi.org /10.1080/10298436.2024.2444502

Gajurel, A. (2014). Performance-Based Contracts (PBC). In: Performance-Based Contracts for Road Projects. Springer, New Delhi. https://doi.org/10.1007/978-81-322-1302-4_3.

Gericke B, Henning T and Greewood I (2014) *A Guide to Delivering Good Asset Management in the Road Sector*

through Performance Based contracting. The International Bank for Reconstruction and Development / The World Bank, Washington DC, USA.

Gupta D, Vedantam A, and Azadivar J (2011) *Optimal Contract Mechanism Design for Performance-Based Contracts*. University of Minnesota, Minneapolis, USA. Retrieved October 15, 2022 from https://conservancy.umn.edu/handle/11299/150077.

Gustriansyah, R., Puspasari, S., Sanmorino, A., Suhandi, N., & Sartika, D. (2025). Tree-based models and hyperparameter optimization for assessing employee performance. *Indonesian Journal of Electrical Engineering and Computer Science*, *38*(1), 569. https://doi.org/10.11591/ijeecs.v38.i1.pp569-577

Hughes W and Kabiri S (2013) *Performance-Based Contracting in the Construction Sector*. University of Reading, Berkshire, England. Retrieved October 15, 2022 from https://centaur.reading.ac.uk/34767/

Hung, L., Chan, C., Yous, M., Connelly, D. M., Wong, K. L. Y., Sakamoto, M., Santaella-Tafolla, P., & Ge, H. (2024). Staff perspective on virtual team-based care in the process of transition to long-term care. *Innovation in Aging*, *8*(Supplement_1), 984–985. https://doi.org/10.1093/geroni/igae098.3170

Molenaar, K. R., & Navarro, D. (2011). Key Performance Indicators in Highway Design and Construction. Transportation Research Record, 2228(1), 51-58. https://doi.org/10.3141/2228-07 (Original work published 2011)

Mulmi, A. (2016) Assessment of Performance Based Road Maintenance Practices in Nepal. *Open Journal of Civil Engineering*, **6**, 225-241. doi: 10.4236/ojce.2016.62021.

Omokhoa, H. E., Odionu, C. S., Azubuike, C., & Sule, A. K. (2025). Building High-Performance Teams and Enhancing Staff Training Through AI-Driven Solutions in Financial Institutions and SMEs. *International Journal of Research and Innovation in Social Science*, *VIII*(XII), 2976–2984. https://doi.org/10.47772/ijriss.2024.8120246

Osei-Asibey, D., Ayarkwa, J., Baah, B., Afful, A. E., Anokye, G., & Nkrumah, P. A. (2024). Impact of time-based delay on public-private partnership (PPP) construction project delivery: construction stakeholders' perspective. *Journal of Financial Management of Property and Construction*. https://doi.org/10.1108/jfmpc-07-2023-0044

Sichoongwe, K. (2025). Infrastructure and economic growth: evidence from Zambia. *African Journal of Economic and Management Studies*. https://doi.org/10.1108/ajems-08-2024-0458

Stankevich, N., Qureshi, N. & Queiroz, C., 2005. *Performance-Based Contracting for Road Asset Preservation and Improvement*, World Bank Group. United States of America. Retrieved from https://coilink.org/20.500.12592/khh6jr on 11 Aug 2025. COI: 20.500.12592/khh6jr.

Sultana M, Rahman A and Chowdhury S (2012) *An Overview of Issues to Consider before Introducing Performance-Based Road Maintenance Contracting*. World Academy of Science, Engineering and Technology 62 2012.

Uwibambe, L., & Njenga, G. (2025). Monitoring and Evaluation Practices and Performance of the Energy Projects in Rwanda: A Case of Electricity Access Rollout Programme (EARP). *International Journal of Entrepreneurship and Project Management*, *10*(1), 1–25. https://doi.org/10.47604/ijepm.3193

Wirahadikusumah R, Susanti B, Coffey V and Adighibe C (2015). *Performance-Based Contracting for Roads–Experiences of Australia and Indonesia.* Procedia Engineering, 125, pp.5-11. Retrieved October 16, 2022 from https://eprints.qut.edu.au/92824/

Xu, C., Zeng, Q., Chen, L., & Yang, S. (2024). Ordinal Clustering Based Homogeneous Road Segments in Asphalt Pavement Maintenance and Rehabilitation Optimized Decision-Making. *Transportation Research Record*. https://doi.org/10.1177/03611981241272090

Zhao, P., Geng, D., She, S., & Duan, M. (2024). Road Traffic Safety Status Analysis and Prediction Based on Dynamic Bayesian Network. *Journal of Physics*, *2868*(1), 012028. https://doi.org/10.1088/1742-6596/2868/1/012028

Zhu, L., Sun, J., Zhang, L., Jing, D., Li, D., & Zhao, X. (2025). ANP-MEAT-based evaluation of the performance of rural infrastructure provision in Mainland China. *Engineering, Construction and Architectural Management*. https://doi.org/10.1108/ecam-08-2024-1088

Zietlow, G. (2016). Performance Based Contracts (PBC): Enabling better RAM. 15th Meeting of the CAREC Transport Sector Coordinating Committee. Bangkok, Thailand.

Алексеев, М. А. (2024). Legislative and regulatory grounds for the formation and development of a mechanism for financial support for the implementation of infrastructure projects. https://doi.org/10.37539/240603.2024.35.12.008

Латаев, Д. О. (2024). Analysis of the regulatory and legal framework governing the activities of participants in

state and municipal procurements. *Vestnik Akademii Prava i Upravleniâ, 3(78)*, 153–156. https://doi.org/10.47629/2074-9201_2024_3_153_156

Data Availability Statement: The study is based on previously published peer-reviewed articles obtained from Scopus and Web of Science databases. The manuscript contains all data which researchers analysed during this review together with supplementary materials. No new primary data were generated for this study.

Funding and Acknowledgement statements: The authors thank the University of Birmingham School of Civil Engineering for their academic support and research infrastructure access and funding through a PGTA Scholarship. The authors thank reviewers and colleagues for their important feedback which improved the quality of this research.

Declarations and Conflict of Interests Statement: The views and interpretations expressed in this article are solely those of the authors and do not necessarily reflect the positions of their affiliated institutions. The authors declare no conflicts of interest with this work.

List of Abbreviations

ADB	Asian Development Bank
AMSTAR 2	A Measurement Tool to Assess Systematic Reviews (Version 2)
CSF(s)	Critical Success Factor(s)
DFID	Department for International Development (United Kingdom)
GIS	Geographic Information System
KPI(s)	Key Performance Indicator(s)
PBMC(s)	Performance-Based Maintenance Contract(s)
PBRC(s)	Performance-Based Road Contract(s) / Contracting
PICO	Population, Intervention, Comparator, Outcome
PPP	Public-Private Partnership
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
ROBIS	Risk of Bias in Systematic Reviews
WoS	Web of Science