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Driving Peru's Road Infrastructure: An Analysis of Public–Private Partnerships, Challenges, and Critical Success Factors

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Abstract: Peru has experienced significant growth but faces challenges with its infrastructure. Despite economic and population growth, competitiveness has not risen at the same pace. The importance of proper roads for economic development and the lack of planning have led the country to confront an infrastructure deficit. This deficit affects connectivity and the quality of the road networks, thereby influencing competitiveness. To bridge this gap, the PPP modality had been used, but challenges were encountered, ranging from the execution of works to maintenance issues. This research study pursues three main objectives: to describe the current landscape of road infrastructure in Peru; to present the Peruvian PPP system and the experience gained through implemented concession contracts; and to identify the critical success factors of Peruvian concessions and propose an evaluation methodology for future contracts. To achieve this, an empirical study of 16 operational road PPPs and a literature review of the most relevant international experiences on success variables for such contracts were conducted. The primary contribution of this study lies in presenting the Peruvian experience and identifying key success factors for this type of contracts in Peru.

Keywords: PPP; critical success factor; road concession; gap; Peru

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1. Introduction

Peru has an area of 1,285,220 square kilometers, making it a large country. It has a population of 33,715,471 people, which represents a low population density of approximately 26 inhabitants per square kilometer.

Peru is one of the countries with the best macroeconomic indicators in Latin America, experiencing significant growth in the past twenty years. In 2022, Peru had a Gross Domestic Product (GDP) in Current Terms that was more than four times higher than that of the year 2000.

The population and economic growth in Peru in the 21st century highlights the importance of infrastructure, which is essential to support economic activity and internally develop the country Urrunaga y Aparicio [1]. Specifically, adequate and high-quality transport infrastructure enhances territorial accessibility, contributes to the country's economic growth, and improves the efficiency of the economic system by reducing transportation costs and times for people and goods.

The lacks of planning and, mainly, ineffective public management have led Peru to a deficit in basic infrastructure that needs attention. The National Infrastructure Plan for Peru's Competitiveness [2] assesses this gap at 108.793 billion USD, recognizing the impact of infrastructure on the country's productivity and competitiveness.

The need to promote new infrastructure at an appropriate pace without increasing the levels of public deficit has led some Latin American governments to resort to the concession system (Bull [3]). The development of high-capacity roads is crucial since these are directly linked to the competitiveness of the country (Ministry of Economy

and Finance [4]). However, the impact of competitiveness can be very limited without a developed road network (Machado & Toma [5]).

The present research has different objectives. Firstly, it describes the current landscape of the road infrastructure in the country. Secondly, a description is given of the road PPP system in Peru and an analysis of the experience gained through the concession contracts that Peru has put into operation. Finally, an analysis is presented of the critical success factors identified in Peruvian concessions, proposing a methodology that enables their incorporation and evaluation in future concession contracts.

To achieve these objectives, an empirical study of the 16 operational road concession contracts in Peru was conducted. Additionally, a literature review of critical success factors (CSFs) identified in scientific literature to ensure the success of a PPP was carried out. The main novelty of this article lies in identifying the CSFs in Peruvian concessions and proposing a simple methodology to assess the suitability of future contracts.

2. Literature Review

In academic and scientific literature, there is a scarcity of dedicated research on Public–Private Partnerships (PPPs) for infrastructure in Peru, especially for roads and highways. Wilson [6] studied the impact of road construction economic policy in Peru, observing how it affected rural Andean society. Calderón et al. [7] suggest that if a Latin American country improves its infrastructure stock to the levels of Chile, the regional leader, it will have long-term per capita GDP growth rates between 1% and 4.8% annually and a reduction in the Gini coefficient to 0.10. Vásquez et al. [8] demonstrated a positive relationship between infrastructure, investment, and long-term per capita GDP. These authors' Essay on the Role of Road Infrastructure in Peru's Economic Growth emphasized the effect of infrastructure on Peru's regional growth, which could reduce inequalities between regions, and the significant short, medium, and long-term economic impact. Estache and Wren-Lewis [9] found that infrastructures are an important vector of economic growth. Cuadrado [10] discovered that infrastructure investment has a greater impact on production and employment than public spending on goods and services. Eduardo Bitran et al. [11] studied the renegotiation of concessional contracts in Chile, Colombia, and Peru. Trebilcock and Rosenstock [12] analyzed the PPP experience in developing countries, focusing on the Latin American experience. Adame [13] quantified that a 10% growth in public investment would generate a 1.3% increase in GDP. Zevallos et al. [14] evaluated highway projects in Latin America and Peru from the point of view of competition. Chong and Valdivia [15] provided evidence of the health impacts of a public–private rural road maintenance program in Peru. Romero and Gideon [16] studied the rise of PPPs in Latin American heath sectors, with a focus on Peru where health PPPs are high on the political agenda. Takano [17] analyzed the competitive aspects of PPPs under Unsolicited Proposals in Peru between 2008 and 2019. Batrancea et al. [18] identified the importance of PPPs in the transition to a green economy. Bonifaz and Fasanando [19] proposed a propensity score matching methodology for the analysis of concessions, using the case of road networks in Peru.

3. Research Framework

Until the onset of the SARS-CoV-2 pandemic (COVID-19) in the first quarter of 2020, Peru had a stable macroeconomic situation, with an average GDP growth rate of 7.17% between 2000 and 2020, public debt levels below 30%, an unemployment rate never exceeding 8%, and a controlled inflation rate below 3% (National Institute of Statistics and Informatics of Peru). Although the crisis caused by COVID-19 altered this scenario, during the years 2021 and 2022, the country was returning to its previous growth path, reaching a nominal GDP of 242.632 billion USD in 2022.

Overall, Peru has experienced higher growth than other countries in the region or OECD member countries (Figure 1).

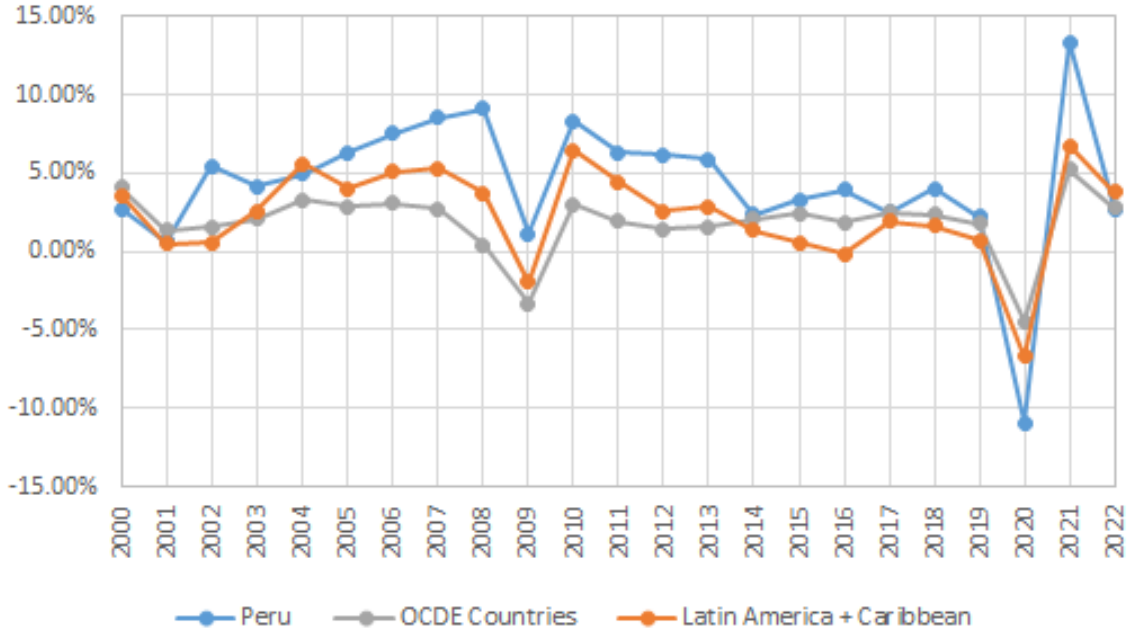


Figure 1. Comparative GDP growth rate. Own creation chart. Data from the World Bank and INEI-Peru.

Peru also has a lower country risk. If we consider, for example, the EMBIG country risk indicator developed by JP Morgan Chase, it shows that over the past 10 years, the country risk for Peru remained below 2%. However, when evaluating Peru's competitiveness from 2008 to 2022, it appeared to be stagnant. The 2022 World Competitiveness Ranking [20] assesses the competitiveness of 63 countries annually based on four pillars: economic performance, government efficiency, business efficiency, and infrastructure. Peru, which has improved by four positions in 2022, ranks 54th out of these 63 countries, with a score of 49.6 out of 100. The report suggests that Peru needs fundamental growth in the infrastructure pillar, including improving its technological, scientific, health and environmental, educational, and basic infrastructures.

The World Economic Forum [21] also compiles a global competitiveness ranking by studying 12 pillars across 141 countries. In its latest edition (Global Competitiveness Report [2]), Peru ranks 65th with a score of 61.7 out of 100, slightly above the average of the 141 countries, which is 60.7 points. The infrastructure pillar of this report identifies and assesses 12 variables. The first two are related to the quality of the road network, with Peru scoring 64 out of 100 for network connectivity and 36.4 out of 100 for its quality. This places Peru globally at positions 102 and 110 (out of 141 countries) in these two dimensions, respectively.

Since 2009, Peru has belonged to the group of middle-income countries (World Bank [22]) with a stable macroeconomic situation (AFIN [23]), reaching a per capita GDP of 7196 USD in 2022, which is a 7.39% increase from the previous year. However, it has a poorer infrastructure endowment compared to countries with a comparable per capita GDP in 2022, such as Mexico (11,000 USD), Colombia (6664 USD), or Brazil (8978 USD). The National Infrastructure Plan for Peru in 2019 came to the same conclusion. This plan identifies and prioritizes 52 infrastructure projects with an approximate investment of 30 billion USD to close the existing infrastructure gap (MEF [4]).

Public infrastructures are the backbone of all economic activity (World Bank [24]). Transport infrastructure enhances the competitiveness of the economic system by reducing costs and transportation times; integrating the territory; and improving the supply, reliability, quality, and quantity of all kinds of services.

Peru will need to make substantial investments in infrastructure in the coming years to reduce its infrastructure gap, especially in the road sector (Urrunaga et al. [25]). This

will not only impact the necessary budget availability, but also the management capacity of various public administrations to invest the allocated resources.

There are several models to estimate the infrastructure gap in Peru. The first model was developed by the Association for the Promotion of National Infrastructure (AFIN) in 2015. In the road sector, the study by AFIN quantified a long-term gap for the period 2016-2025 of 31.85 billion USD. Another model was proposed by the Ministry of Economy and Finance (MEF) of Peru in 2019 in the National Infrastructure Plan for Peru's Competitiveness. This report established Peru's long-term infrastructure gap (2019–2038) based on different groups of comparison countries. To align Peru with middle-high- and high-income countries, the calculated gap was 31.654 billion USD. Finally, there is a third model developed by the Inter-American Development Bank (Bonifaz et al. [26]). This study calculated a long-term gap in road investments of EUR 32.006 billion. Taking the described situation as a starting point, Peru must promote the provision of infrastructure in the coming years, particularly in the road sector.

3.1. Roads in Peru

Roads in Peru play a crucial role in the country's economic development and connectivity due to its extensive territory and diverse geography. Roads in Peru are classified into a national road network, a departmental or regional road network, and a local or rural road network (Supreme Decree 017-2007-MTC [27]). The national network is under the jurisdiction of the Ministry of Transport and Communications (MTC), the regional network is managed by regional governments, and the local network is overseen by local governments (National Road Infrastructure Management Regulation [28]).

At the end of the 1980s, Peru had 69,942 km of roads, with only 11% of that length paved. In 2021, the total length of roads had increased to 175,590 km, according to the details provided in Figure 2 (total kilometers on the secondary axis).

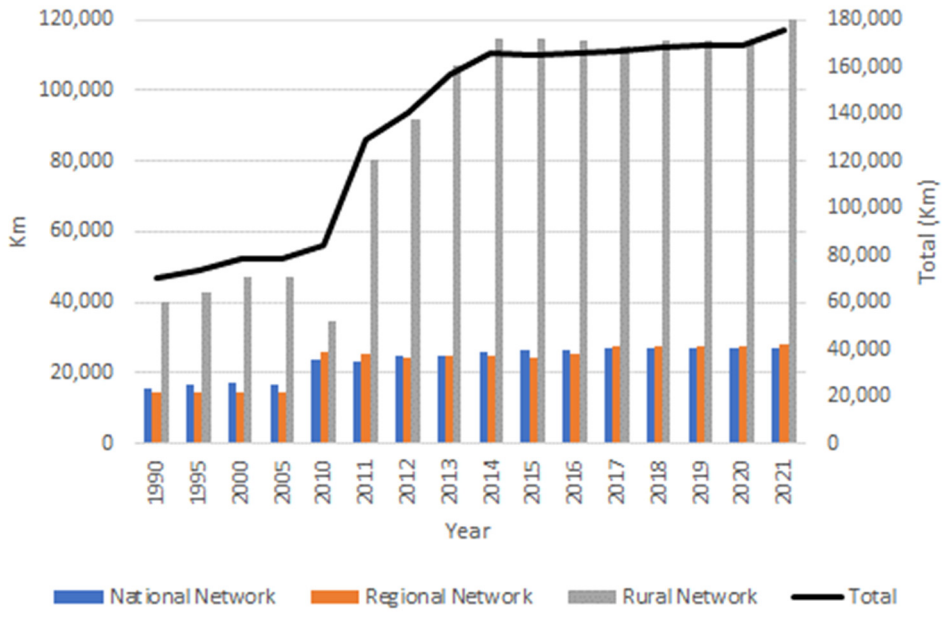


Figure 2. Road network evolution. Authors' chart. Data from MTC and OSITRÁN.

Of the approximately 27,000 km in the national network in 2021, 83% were paved, making it the network with the most growth in paved kilometers. In the same year, of the 27,951 km in the regional network, only 15% were paved. As for the rural network, which expanded the most, reaching 120,593 km, only 2% were paved in 2021. A quarter of the kilometers in the national network are managed through Public–Private Partnerships (PPPs), totaling 6,563 km, although they bear 83% of the traffic on this network (OSITRÁN [29]).

In 2021, the Ministry of Transport and Communications (MTC) determined that 33% of the national road network was in a condition classified as regular or poor quality. The Peruvian Institute of Economics [30] estimated that many quality issues stemmed from inadequate road maintenance, as the percentages of GDP allocated to these activities had decreased, reaching only 0.36%. For example, Rioja [31] suggests an annual maintenance expenditure of 2% of GDP for Latin American countries. The poor quality of roads also has a negative impact on the number of accidents, as studied by Indigoyen et al. [32].

3.2. Modalities of Infrastructure Provision in Peru

The traditional modality of providing public infrastructure in Peru involves the state taking on the design, construction, and operation of a project using budgetary resources. However, the Competitiveness Report 2019 (Peru Compete, Private Competitiveness Council) points out two significant problems with this modality: delays in the scheduled phases of project bidding and awarding, and deficiencies in technical documents that lead to an average 30% increase in estimated project costs. On the other hand, closing the infrastructure gap requires a consistent volume of investment over time that cannot be entirely met with budgetary resources, especially if the country does not want to increase its levels of deficit and public debt.

Alternatively, infrastructure investment can be carried out through Public–Private Partnerships (PPPs), as indicated by Qiu and Wang [33]. This modality appeared in Peru in the 1990s, but it was Legislative Decree 1012 [34] in 2008 that formally introduced such PPPs. In 2015, Legislative Decree 1224 [35] implemented a new specific system for the development of these types of projects, but it was in 2018 when Legislative Decree 1362 [36] established the foundations of the current PPP system. In 2020, the PPP Methodological Guide (MEF, 2020) was introduced, aiming to facilitate the understanding and application of this investment modality in Peru to promote infrastructure and public service development.

The World Bank [37] defines PPP as a "long-term contract between a private party and a public entity, for the provision of a public asset or service in which the private party bears significant risk and management responsibility, and remuneration is linked to performance".

Numerous authors have analyzed the advantages and disadvantages of PPPs. For example, Engel, Fischer, and Galetovic [38] examined when PPPs are better than conventional provisions. Bovaird [39] explored the collaborative advantages of PPPs, and Tsamboulas et al. [40] analyzed why governments choose PPPs for infrastructure provision and operation. The European Union in its "Guidelines for Successful Public Private Partnerships [41]" highlights advantages such as rapid implementation of infrastructure, which reduces a project's lifecycle cost, improves incentives for better quality, and generates additional income. Additionally, the "User Guidebook on Implementing PPP for Transportation Infrastructure Projects in the United States [42]" emphasizes increased efficiency, access to new private capital, and the opportunity for public agencies to focus on their strengths as the main advantages.

Sarmento et al. [43] identified some clear advantages of PPPs in his research. Firstly, PPPs may not be accounted for in a country's public accounts during the investment phase. They also make it possible to construct infrastructure that would not otherwise be feasible due to the budgetary constraints of the public entity. Furthermore, PPPs generate "Value for Money," by allocating risks to private promoters based on their greater ability to efficiently manage them, thus allowing the government to focus on other areas besides the operation and commissioning of infrastructure, and simplifying the contractual relationships for the public entity.

Bonifaz and Fasanando [19] compared the average accident rate, cost overruns, and delays of concessioned road sections with the estimated levels these sections would have had if they had not been concessioned using the propensity score matching methodology. The main result was that the accident rate, the number of injuries, the number of deaths, cost

overruns, and delays were lower in concessioned road sections than in non-concessioned sections for the Peruvian case.

To promote private investment in Peru, the Private Investment Promotion Agency (ProInversion) was created in 2002. ProInversion, a specialized technical agency under the Ministry of Economy and Finance (MEF), highlighted numerous benefits of PPPs compared to the traditional system. These included leveraging the private sector's know-how, generating budgetary certainty, and better project control for the administration. In its "Methodological Guide for Public-Private Partnerships [44]", ProInversion established that in Peru, the development of PPPs is driven by three main reasons: closing the gap in public infrastructure, improving the scope and quality of public services, and stimulating the national economy, thereby generating productive employment and increasing the country's competitiveness.

The mentioned Legislative Decrees 1224 [35] and 1362 [36] briefly outline the most important principles to be addressed in a PPP in Peru: transparent and competitive bidding, value for money, and an appropriate risk distribution in the contracts between the public and private sectors. According to the World Bank [45], Peru has a very suitable legal framework for PPP development. However, the lack of a proper set of performance indicators makes it impossible to adequately measure the success of these projects in the country.

3.3. PPPs in Peru

Based on the type of financing, PPPs in Peru can be self-sustainable or co-financed. Depending on who promotes the project, a PPP can be publicly or privately initiated. Projects can be national, regional, or local in scope.

In an emerging market context, it is more likely that a project will need to be self-financing. In these cases, the concession is financed based on demand, with some form of payment from infrastructure users. Construction and demand risks are primarily transferred to the concessionaire. In co-financed projects in Peru, the public entity pays the concessionaire the amounts for both construction and maintenance and operation. Although there is also a payment from users, construction and infrastructure availability risks are shared between the grantor and the private sector. The country uses this mechanism to promote certain projects that are of social interest but are not economically viable through user fee payments. As Paz [46] asserts, co-financing is clearly a subsidy for users.

Regarding the bidding process, there are three alternatives: open bidding, competitive dialogue, and negotiated procedure. So far, in road PPPs worldwide, the open bidding modality has always been used.

The awarding of contracts is based on what is known as competitive factors. These factors are instruments used to compare the economic bids presented by different bidders in the bidding process. These factors can be classified into three groups: economic returns for the grantor, proposals for additional works, and annual payments for the concessionaire.

In the case of co-financed concessions, the following competitive factors are identified: annual payment for works (PAO), annual payment for maintenance and operation (PAMO), payment for rehabilitation and improvement (PRM), and annual payment for initial periodic maintenance (PAMPI). It is observed that the evaluation criterion in the awarding process is mainly oriented toward selecting a bidder that requires a lower co-financing cost from the State.

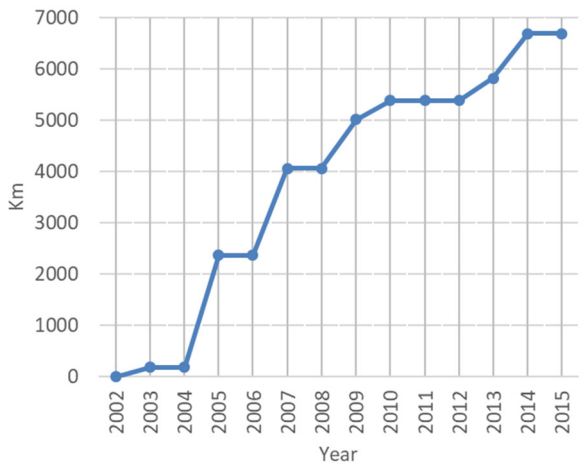
In the case of self-financed concessions, the following competitive factors are identified: the quantity of continuous kilometers to be built above the minimum set by the State, a higher return for the State expressed as a percentage of monthly toll revenue, and the quantity of works to be executed in addition to the mandatory minimum works. In this regard, it is noted that the evaluation criterion in the awarding process is mainly oriented toward selecting a bidder that provides greater benefit to the State in terms of income or works to be executed.

The first concessional road project in Peru dates back to 1994, involving the refurbishment and maintenance of the Arequipa-Matarani highway. Although this project was pioneering, it did not achieve the expected results due to the lack of experience in managing this type of contracts (Nalvarte [47]).

In 2003, ProInversion and the Ministry of Transport awarded Peru's first significant road Public–Private Partnership (PPP): the Road Network No. 5.

Concurrently, at the regional level, Peru became part of the "Initiative for the Integration of South American Regional Infrastructure (IIRSA)." This initiative aimed to plan and develop regional projects in transportation, energy, and telecommunications. In terms of transportation, Peru was part of four regional axes: the Andean Axis (with two longitudinal axes: Coast and Sierra), the Amazon Axis, and the Peru–Brazil–Bolivia Axis. As a result, in 2005, five more contracts were promoted: sections 2, 3, and 4 of IIRSA South, IIRSA North (the first co-financed concession in roads), and Road Network No. 6.

In the same year, there was the launch of the "Costa-Sierra Program," which included three new PPP projects: Empalme 1B, Tramo Vial Costa-Sierra, and Óvalo Chancay. In 2007, concessions were signed for IIRSA South T1, IIRSA South T5, and Empalme 1B, and in 2009, agreements were reached for the Road Network No. 4, Autopista del Sol, Tramo Vial Costa-Sierra, and Óvalo Chancay. In 2013, a new concession was signed for a section of the Pan-American Highway running from Ica to the border with Chile. A year later, in 2014, the latest road concession to date was signed: the Longitudinal de la Sierra Tramo 2. In total, there were 16 Public–Private Partnership (PPP) contracts for roads in Peru signed between 2003 and 2014, totaling 6,694 km, as detailed in Figure 3. Among these 16 contracts, only six are self-sustainable: Road Network No. 4, Road Network No. 5, Road Network No. 6, Autopista del Sol, IIRSA Centro, and Tramo Vial Panamericana.



Project	Contract signing date
Red Vial N°5	15-Jan-03
IIRSA Norte	17-Jun-05
IIRSA Sur T2	4-Aug-05
IIRSA Sur T3	4-Aug-05
IIRSA Sur T4	4-Aug-05
Red Vial N°6	20-Sep-05
Empalme 1B	9-Feb-07
IIRSA Sur T1	23-Oct-07
IIRSA Sur T5	24-Oct-07
Óvalo Chancay	20-Feb-09
Red Vial N°4	18-Feb-09
Tramo Vial C-S	30-Apr-09
Autopista del sol	25-Aug-09
IIRSA Centro	27-Sep-10
Tramo Vial Panamericana	30-Jan-13
Longitudinal de la Sierra T2	28-May-14

Figure 3. Km of road in PPPs and details of the different contracts. Authors' chart based on OSITRÁN data.

The maximum term for a concession contract in Peru is 60 years, according to Article 52 of Legislative Decree 1362 [36]. In practice, the observed terms in the 16 existing projects are shorter, following international recommendations. In 12 of the 16 concessions, the term is 25 years; in one contract, it is 30 years; and in three contracts, it is 15 years. Overall, it is observed that self-sustainable projects have longer terms, with 25 years in five cases and 30 years in the remaining case.

The size of the contracts also varies widely, with co-financed contracts being larger, as can be seen in Figures 4 and 5.

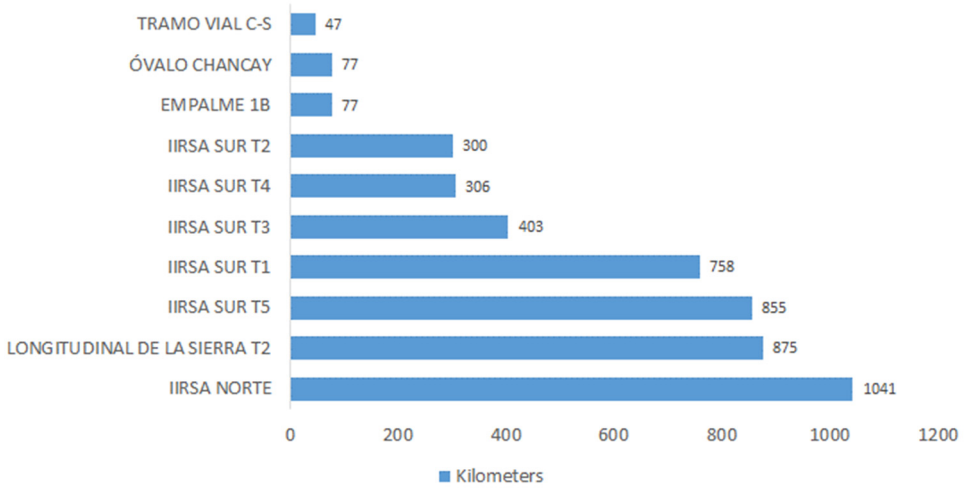


Figure 4. Km of co-financed concessions. Authors' chart based on OSITRÁN data.

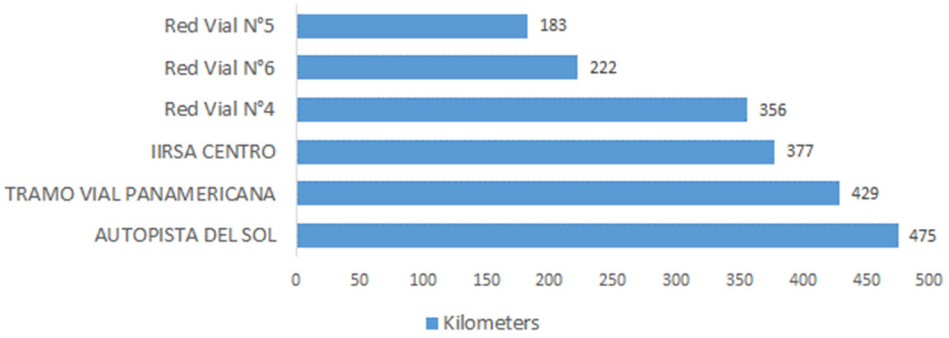


Figure 5. Km of self-financed concessions. Authors' chart based on OSITRÁN data.

The road Public–Private Partnership (PPP) contracts in Peru can be classified into four groups: new construction, lane widening, road refurbishment and improvement, and road maintenance. They can also be differentiated based on how their investment is determined: lump sum or unit prices. The following Figure 6 details the nature of each of the 16 concession contracts based on the kilometers corresponding to each group of activities.

Project	New Construction	Road Splitting	Refurbishment and improvement	Maintenance
RV N°4		284		
RV N°5		91	92	
RV N°6	149	72	73	150
IIRSA NORTE	114		927	
IIRSA SUR T1			758	
IIRSA SUR T2	246			
IIRSA SUR T3	411			
IIRSA SUR T4	277			25
IIRSA SUR T5	104		798	
Empalme 1B			77	
Autopista del Sol		263		475
Tramo Vial Nuevo Mocupe-Cayaltí-Oyotún			35	11
Óvalo Chancay	55		22	
IIRSA Centro T2			377	
Tramo vial Panamericana		74	429	
Longitudinal de la Sierra T2			91	785
Total length (Km)	**1356**	**784**	**3679**	**1446**

Figure 6. Km of concession contracts based on groups of activities. Authors' chart.

The works to be executed are classified into mandatory, ancillary, and additional. Ancillary works are unforeseen works necessary for a project that not included in the

concessionaire's bid. Additional works are complementary works decided throughout the concession to enhance the project, although they are also not included in the concessionaire's bid. All additional works are the responsibility of the corresponding contracting authority and lead to a renegotiation of the contract.

In self-sustainable concessions, the concessionaire receives a toll from users, although in some cases, they are entitled to a guaranteed annual minimum income (IMAG) from the administration. In co-financed concessions, the concessionaire mainly receives an annual payment for works (PAO), an annual payment for maintenance and operation (PAMO), an annual payment for rehabilitation and improvement (PRM), and a toll from users.

Regarding demand, self-sustainable concessions have higher traffic volumes than co-financed ones. While the former reached 16 million vehicles annually in 2022, the latter generally had annual traffic volumes below 2 million vehicles.

In 2022, the average toll price in co-financed projects was 0.011 USD/km, and in self-sustainable projects, it was 0.034 USD/km.

The planned investment for these sixteen contracts in nominal terms was 2.516 billion USD. Today, with the information available, we know that the total committed investment in these projects reached 4.983 billion USD. This significant difference in investment is justified by the substantial number of additional works that were conducted over the years.

Recent history has shown that all these PPP projects required numerous unforeseen addendums to give continuity to the contracts. In total, sixty-six addendums were signed for these contracts based on the following fundamental issues: execution and acceptance of works, maintenance of works, service levels to be guaranteed during operation, alteration of the economic and financial balance of the concession, land expropriations (land acquisition), and tolls. In general, problems related to the execution of works were important and their number was much higher than the rest, although there were also many problems arising from the lack of available land for the works due to inadequate expropriation planning. All of these led to delays, sometimes incredibly significant, and contract renegotiations.

Although Peru must develop a considerable number of new infrastructures to close the existing gap, the country needs to have mechanisms in place to ensure the successful development of these projects and to avoid many of the problems that occurred in the past, which resulted in such a high number of contract renegotiations. Normally, "Value for Money (VfM)" is a good indicator of whether a project will offer more value by developing it based on the PPP mode than based on the traditional method. However, VfM application is not straightforward, and it was decided not to implement it in Peru (World Bank, 2020 [48]). Instead, this methodology was replaced by certain eligibility criteria. Nevertheless, the application of these criteria has not always yielded the expected results.

In the present research, the authors propose critical success factors (CSFs) to ensure the successful development of a PPP project by identifying and analyzing those present in the 16 Peruvian concession projects. Based on these critical success factors and accumulated experience, a new eligibility formula is proposed for future projects.

4. Data and Methodology

Numerous publications are dedicated to identifying critical success factors (CSFs) to ensure success in Public–Private Partnership (PPP) projects. In this research, the ten most relevant articles indexed in the Journal Citation Report were selected based on the number of citations. Zhang [49] identified CSFs in PPPs for infrastructure development. Olusola et al. [50] identified CSFs in PPP infrastructure projects in Nigeria. Wegrzyn [51] analyzed the perception of CSFs in PPPs based on the interests of different project participants. Bing Li et al. [52] identified 18 CSFs in UK PPP projects. Hsueh et al. [53] analyzed CSFs in Taiwan. Debela [54] studied CSFs in road PPP projects in Ethiopia. Surachman et al. [55] studied CSFs in PPPs in developing countries, focusing on the experience in Indonesia. Simon et al. [56] developed a theoretical framework of success conditions for social infrastructure PPP projects. Ngullie et al. [57] established CSFs based on the

perception of different stakeholder groups in India. Belay et al. [58] used the Delphi-AHP method to identify success factors in construction projects in emerging countries.

The seventeen most notable CSFs present in all these works based on their importance are as follows:

- CSF1: Transparent, competitive, and efficient bidding process. These three conditions are part of the Peruvian principles to promote a Public–Private Partnership (PPP). All bidders must have the same information and specifications to ensure that each of them has an equal opportunity to win the contract.
- CSF2: Political and government support. This is essential for the development of PPP projects to lend credibility to the endeavor and to attract financing in a highly competitive market.
- CSF3: Good governance. To ensure the success of a PPP, strong, competent, productive, and responsible government and public institutions are indispensable. Investors typically seek countries with institutional and legal security for their investments.
- CSF4: Favorable legal framework, especially for licensing and land acquisition (expropriations). A favorable legal framework enhances a country's ability to attract the private sector and investors, as it facilitates the swift and secure implementation of a PPP by providing legal certainty. This is particularly beneficial in the case of expropriations and construction permits, which have caused significant delays in projects in Peru.
- CSF5: Favorable economic policy. A sound economic policy provides stability and economic growth, both of which are essential for a project that, by its nature, is often long-term in nature.
- CSF6: Mature and available financial market. This success factor ensures local project financing, lower intermediary costs, and reduced financial expenses. It also facilitates access to international capital markets.
- CSF7: Community support. Community support is crucial. In Peru, some projects faced challenges due to community resistance.
- CSF8: Proper risk allocation. In a PPP project, risks should be allocated to the party best equipped to manage them. This creates incentives for risk management and contributes to the economic efficiency of the project. It is one of the most crucial success factors in ensuring the viability of a PPP.
- CSF9: Stable political and social environment. In a capital-intensive and long-term project, the presence of a stable political and social environment is fundamental.
- CSF10: Multiple stakeholder benefit objectives. International experiences show that PPPs are successful when all stakeholders realize the anticipated benefits of such projects.
- CSF11: Well-organized and committed public agency. It is necessary to have a group of individuals within the administration with knowledge and experience in PPPs to effectively manage projects at all stages.
- CSF12: Government participation through guaranteed provision. Some projects may be socially valuable but not attractive to investors. In these cases, it is important for the government to provide guarantees to make these projects economically and financially viable.
- CSF13: Comprehensive and realistic cost and benefit assessment. A PPP project is successful if it adds value from both a socio-economic and an economic–financial perspective by thoroughly considering all its benefits and costs for all parties involved.
- CSF14: Stable macroeconomic environment. Countries become attractive for such investments when they possess a stable macroeconomic environment, which diminishes investor uncertainty and enhances the feasibility of projects.
- CSF15: Shared authority between the public and private sectors. A PPP is a partnership between the public and private sectors. It is important to maintain a good balance of power between both parties.

- CSF16: Presence of strong private consortia. This ensures that the process will be competitive and efficient, allowing the most promising projects to move forward.
- CSF17: Technical feasibility of projects. For a project to be successful, it must be technically feasible and developed in a manner that does not face significant technical risks.

After identifying the seventeen most important CSFs in PPP projects, their impact on the sixteen operational concession projects in Peru was analyzed. If a CSF was present in a project, it was assigned a value of 1; otherwise, it was assigned a value of 0. The CSF numbers 2, 5, 6, 9, 11, 12, 14, 15, and 16 were present in all studied projects and were always fulfilled in Peru, making them the discriminatory factors. In other words, if these conditions were not met a priori, no PPP project should be developed. The remaining factors, referred to in the present study as impact factors, were not always present in Peruvian concessions, thus explaining some of the issues that arose. For example, CSF number 4, a favorable legal framework for licensing and expropriations, did not always exist in Peru, which explained many project delays and renegotiations. These impact CSFs need to be evaluated in future concessions to ensure project success.

The following table (Figure 7) details the selected CSFs in the case of Peru after eliminating the discriminatory factors.

		CRITICAL SUCCESS FACTORS							
		CSF1	CSF3	CSF4	CSF7	CSF8	CSF10	CSF13	CSF17
PROJECT	Red Vial N°5	1	0	0	0	1	1	1	1
	IIRSA NORTE	1	0	1	1	0	0	0	1
	IIRSA SUR T2	0	1	0	1	0	1	0	0
	IIRSA SUR T3	0	0	0	1	0	0	0	0
	IIRSA SUR T4	0	1	0	0	0	1	0	0
	Red Vial N°6	1	0	0	1	1	0	1	1
	EMPALME 1B	1	1	0	1	0	1	0	1
	IIRSA SUR T1	1	0	0	1	0	1	1	1
	IIRSA SUR T5	1	1	1	1	0	0	1	1
	ÓVALO CHANCAY	1	1	0	1	0	1	0	1
	Red Vial N°4	1	1	0	1	0	1	0	1
	TRAMO VIAL C-S	1	1	0	0	0	1	0	1
	AUTOPISTA DEL SOL	1	0	0	1	1	0	1	1
	IIRSA CENTRO	1	1	0	0	1	1	1	1
	TRAMO VIAL PANAMERICANA	1	1	0	0	1	1	1	1
	LONGITUDINAL DE LA SIERRA T2	1	0	0	1	0	0	0	1

Figure 7. Critical success factors present in Peruvian road concessions. Authors' chart.

This research proposes a straightforward methodology to assess the success of a concession project that is applicable to any new projects. To promote a new project in Peru, the first thing to verify is the fulfilment of the so-called discriminatory success factors, as they represent inevitable conditions in the environment according to international experiences for successfully developing a project. Next, a project rating formula is proposed based on the presence of impactful critical success factors (CSFs) and their significance, as determined by their past relevance to the success or failure of the sixteen concessions studied. If a CSF is present in a project, it will be assigned a value of one (1); otherwise, it will be assigned a value of zero (0). This score should weigh the importance of each CSF based on the Peruvian experience. The proposed expression is as follows:

$$SCORE = CSF1 * w1 + CSF3 * w3 + CSF4 * w4 + CSF7 * w7 + CSF8 * w8 + CSF10 * w10 + CSF13 * w13 + CSF17 * w17.$$

where:

- CSFi is a binary variable that takes a value of 0 or 1.
- wi is the weighting coefficient for each CSFi in the final score achieved.

The wi values are chosen in such a way that their sum equals one. In other words, for a project where all CSFs are present, the maximum score attained will be one. Conversely, if all CSFs are absent, the minimum score will be zero. The analysis of the 16 Peruvian projects suggests that projects with a score below 0.5 should be abandoned, those with a score between 0.5 and 0.6 should be reviewed, and those with a score above 0.6 should be accepted.

To determine the wi values, this study considered the instances in which a specific impactful CSFi was absent in the sixteen projects analyzed. For example, CSF4 was absent in fourteen out of the sixteen projects studied. Therefore, wi = (14/16)/3.5 = 0.25, where 3.5 is a constant that ensures the sum of all wi values equal to 1. Figure 8 summarizes the different wi values obtained.

w1	w3	w4	w7	w8	w10	w13	w17
0.054	0.125	0.250	0.089	0.179	0.107	0.143	0.054

Figure 8. CSF weighting coefficients.

5. Results

Applying this evaluation criterion to each of the sixteen projects studied, we obtained the scores indicated in Figure 9. We can now infer that some of the projects studied should not have been developed because their score is low, primarily due to the absence of certain CSFs. This assessment aligns with the experience gained from these projects, which, in many cases, required multiple renegotiations.

Project	Score
Red Vial N°5	0.55
IIRSA NORTE	0.43
IIRSA SUR T2	0.31
IIRSA SUR T3	0.09
IIRSA SUR T4	0.22
Red Vial N°6	0.53
EMPALME 1B	0.41
IIRSA SUR T1	0.45
IIRSA SUR T5	0.71
ÓVALO CHANCAY	0.41
Red Vial N°4	0.41
TRAMO VIAL C-S	0.33
AUTOPISTA DEL SOL	0.53
IIRSA CENTRO	0.67
TRAMO VIAL PANAMERICANA	0.67
LONGITUDINAL DE LA SIERRA T2	0.19

Figure 9. Proposed valuation for the projects. Authors' chart.

Some projects, such as IIRSA Sur T2, T3, and T4, received poor evaluations. These projects were involved in the corruption process known as "Lava Jato", where different companies engaged in paying commissions to public officials in exchange for contract awards, leading to a lack of a transparent, competitive, and efficient bidding process (CSF1). There were also significant issues with land availability (CSF4); these projects were co-financed by the state and lacked a proper distribution of risks (CSF8), or the technical viability of these projects was completely ignored due to political pressures (CSF17). Generally, projects lacking good governance (CSF3) or facing issues such as

expropriations (CSF4), improper risk allocation (CSF8), or poor assessment of costs and benefits (CSF13) received poor evaluations. Consistent with the experience gained from the sixteen studied contracts, it can be observed that CSFs 3, 4, 8, and 13 have a significant impact on the success of projects, as reflected in their poor evaluations.

If we graphically represent this information according to the chronology of the contracts (Figure 10), it can be observed that their assessment based on the provided criteria has increased (see red trend dotted line), suggesting a better outcome in the development of these projects due to accumulated experience.

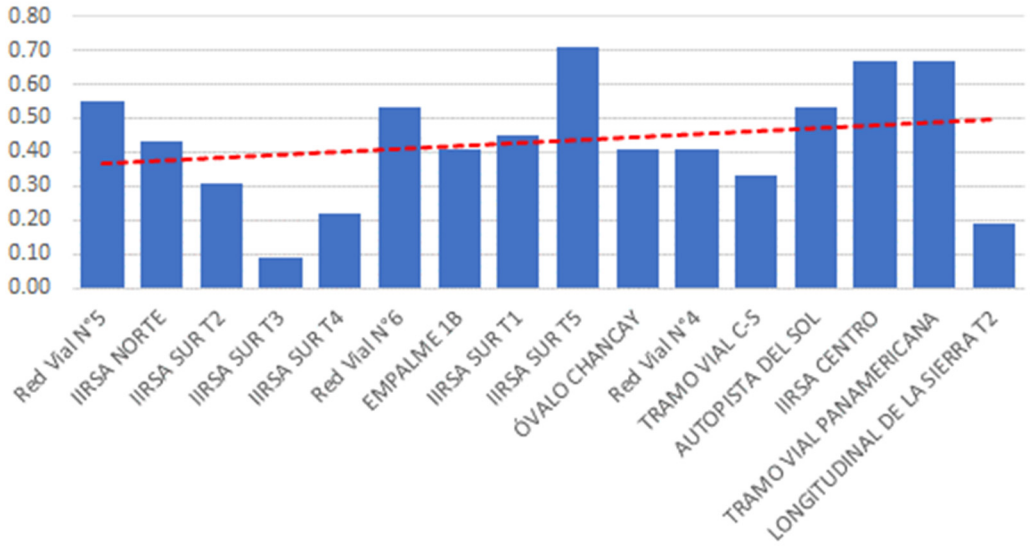


Figure 10. Contract valuation. Authors' chart.

6. Conclusions

With its vast territory and growing economy, Peru faces the challenge of bridging the infrastructure gap to sustain and enhance its economic development. The present research focuses on the road sector, acknowledging the pivotal role transport infrastructure plays in economic competitiveness.

The country's macroeconomic indicators, until the onset of the COVID-19 pandemic, portrayed a stable and growing economy, which was marked by an impressive GDP growth and controlled inflation. However, despite this economic prowess, Peru lags behind in global competitiveness rankings, specifically in infrastructure. The need for substantial investments in this sector is evident, as highlighted by numerous studies and reports, including the National Infrastructure Plan for Peru's Competitiveness, which values the infrastructure gap to be 108.79 billion USD.

The present paper delves into Peru's road infrastructure, emphasizing its evolution over the years and the current state of various road networks. The analysis reveals disparities in pavement condition ratios among different networks, with a significant portion of the national network managed through Public–Private Partnerships (PPPs). The challenges of road quality and maintenance are underscored, thus impacting not only economic considerations but also safety aspects, as indicated by studies on accident rates.

The modalities of infrastructure provision in Peru were then analyzed by comparing traditional state-led approaches with PPPs. The advantages of PPPs, such as leveraging the private sector's expertise, budgetary certainty, and risk sharing, are highlighted. The legal framework supporting PPP development in Peru is considered favorable, but challenges in project evaluation and performance measurement are acknowledged.

The present research provides an in-depth examination of sixteen road PPP contracts implemented between 2003 and 2014. These projects were categorized based on financing, scope, and size, shedding light on the diversity of road infrastructure development in the country. The analysis of these contracts reveals challenges such as contract renegotiations,

delays, and unforeseen addendums, prompting the need for a more robust evaluation methodology.

To address these challenges, the authors proposed a comprehensive set of 17 critical success factors (CSFs) based on an extensive review of international literature. These CSFs encompass aspects ranging from transparent bidding processes and political support to legal frameworks, community engagement, and technical feasibility. This research study suggests a scoring methodology to evaluate future PPP projects by considering the presence of these CSFs in Peruvian road concessions. This evaluation methodology takes into consideration the importance that each CSF has had in the past in the success of each concession. Specifically, the existence of good governance (CSF3) and a favorable legal framework for obtaining licenses and land acquisition (CSF4), correct risk assignment (CSF8), and a comprehensive and realistic cost and benefit assessment (CSF13) have had an influence in determining the success of Peruvian concessions. According to the proposed methodology, some projects obtain a very low assessment, such as IIRSA Sur T2, T3, and T4, and Longitudinal de la Sierra 2.

The present methodology could be generalized to the evaluation of other projects, but it should be reviewed with empirical data to identify the appropriate critical success factors (CSFs) and the weighting each of them has in that specific type of projects.

The main implication of this methodology is that no project that does not reasonably meet the identified CSFs should be developed. However, this will not guarantee the success of new projects as it requires the presence of expert PPP officials who monitor the projects in all their phases to ensure their success.

In conclusion, the findings underscore the importance of robust planning, transparent processes, and adherence to critical success factors for successful road infrastructure development in Peru. As the country strives to close its infrastructure gap, incorporating these factors into future projects could contribute to more effective and sustainable outcomes, thereby fostering economic growth and enhancing global competitiveness. The proposed evaluation methodology provides a practical tool for decision makers to assess the viability of PPP projects by drawing on the lessons learned from past experiences.

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