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Cross-Country Comparison of Risk Factors in Public–Private Partnerships in Infrastructure Development: Evidence from Colombia, Kazakhstan, and Ghana

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Abstract: Governments enter into public–private partnership (PPP) agreements to attract private financing and bring innovation to the development of their sustainable public infrastructure; however, PPP projects are marked by their complexity and are driven by uncertain economic and institutional environments. The purpose of this study is to conduct a cross-country comparison of PPP risks in three developing countries (Colombia, Kazakhstan, and Ghana) and provide insights into their best practices. The research surveyed diverse risk factors involving 261 local respondents with pertinent experience in PPPs. The study conducted Cronbach’s alpha and Kendall’s coefficient of concordance tests to check the validity of responses, an ANOVA test to examine the differences in the risk perceptions, and risk ranking to reveal the country-specific as well as top-rank risks in the countries. The results of the quantitative analysis revealed risk aversion among developing countries with PPP programs at different maturity stages. Less mature programs, with lower overall investment, exhibited greater overall risk aversion (for Kazakhstan) and greater concerns about transparency and corruption (for Ghana). Highly populated countries with more mature PPP programs that rely significantly on transportation projects demonstrated higher risk aversion regarding the social and political legitimacy of PPPs and land acquisition (for Colombia).

Keywords: Colombia; Ghana; infrastructure; Kazakhstan; public–private partnerships; risk factors



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1. Introduction

The practice of using public–private partnerships (PPPs) has become a global trend. A PPP is defined as a long-term agreement between a government entity and a private partner to deliver a sustainable service for public use, in which the latter takes a significant risk and brings innovation [1,2]. PPPs are increasingly attractive in developing countries, where governments struggle with budget expenditures for the realization and operation of their infrastructure facilities [3–6]. In particular, by entering into such agreements, governments attract private financing for the capital expenditures and expertise in the design, construction, and operation of public facilities for enhancing performance through innovation and technology under a lifecycle perspective [7–9]. Also, PPPs are used extensively due to the immense need for sustainable infrastructure services (energy and power, health-care, transportation, water, sanitation etc.) to satisfy the growing demands of emerging economies [10].

PPP programs are based on a project financing mechanism that constitutes the capital of private partners and funding institutions [11]. In PPPs, a special-purpose vehicle (SPV) is created, a consortium that acts as a central body that constructs, operates, and maintains

the facility for a predetermined concession period [12]. Throughout the period, the invested capital is obtained from the facility end users, utility company, or agency that acquires it.

While PPPs have the potency to bring sizeable benefits to economies, such as higher value for money, technological innovation, and increased efficiency, there are also risks bonded with these complex partnerships [13–15]. Some risks are exclusively inherent to a PPP project, associated with its long concession period (e.g., 25 years), partner collaborations, and large financing architecture, implying greater uncertainty about project planning, construction, and operation. Other risks are extrinsic, which can arise due to political, government, economic, financial, and natural conditions in the wider PPP environment [16,17].

If risks are not managed in a PPP construction project on time or not properly allocated between the partners, this can induce construction delays, budget overruns, poor customer satisfaction, or even project failure [3,18]. Therefore, understanding and addressing the relevance and implications of each risk factor are vital for the success of PPP projects. Therefore, effective risk assessment is critical to ensuring project resilience and achieving desired outcomes. By comprehensively analyzing and managing these risk factors, stakeholders can enhance their PPP services' feasibility, sustainability, and profitability in the complex business environment associated with this project delivery approach.

The PPP risk management body of knowledge has grown dramatically, especially among studies from developing countries; however, the literature is frequently restricted to single case studies or certain groups of risks instead of a comprehensive analysis [10]. In the next section, we provide a pertinent literature review of PPP risk management studies. For the most comprehensive review of risk-related studies in PPPs, we refer readers to Osei-Kyei et al. [13] and Esperilla-Niño-de-Guzmán et al. [19]. Among earlier works is the study by Bing et al. [20], who delved into risks in PPP construction projects and combined 46 risks into 13 groups, comprising three meta-levels (macro, meso, and micro) of risk factors. The compiled risk register specific to PPP construction projects in the UK became the main data source of risks for further studies in multiple countries [21]. Ke et al. [22] studied the risks in China's PPPs. They ranked the most significant risks, which included poor public decision making, political interference, financial risks, corruption, interest rate hikes, inflation, and a deficient legal system. Ameyaw and Chan [3] identified 40 risk factors in a more extensive study. By interviewing experts, the authors compiled critical risk factors such as poor contract design, political interference, time and cost overruns, lack of experience in PPPs, wrong demand forecasts, financial risks, and conflict between the parties. Sy et al. [23] studied risk factors in PPPs in transportation in Vietnam. The authors reviewed the literature and identified 38 risk factors for further interviews and surveys among the public and private sectors. All risks were analyzed and ranked, assessing 23 risk factors with a high risk level.

Despite the diversity of the risk factors in PPPs, the review studies in the field deduce a significant consensus among scholars regarding the taxonomy of the most significant risk factors in PPPs [5,24,25]. Broadly, the risks in the literature are grouped into political and government, economic, legal, construction, and SPV-related [26,27]. Such a grouping of risk factors provides a comprehensive framework with which to understand and assess the various types of risks that can impact the success and sustainability of such projects. Each risk group holds specific relevance and implications, which are crucial for stakeholders involved in PPP projects who can effectively identify, manage, and mitigate potential risks.

A considerable body of research has studied the risk factors in PPP projects [28,29]. Nevertheless, most of these studies have focused on individual countries or infrastructure types, limiting their applicability. Consequently, the insights gained from previous studies offer limited contributions to international best practices in PPPs. Furthermore, these studies lack a comprehensive comparison of the potential risk factors that may be similar or different across multiple developing countries. An inductive analysis of such factors within specific countries could significantly enhance our understanding of PPPs on a global scale for developing economies in different regions. This constitutes a research gap in the

existing literature, which lacks a cross-country comparison of PPP risks with inductive analyses of the risks from each country.

The purpose of this study is to conduct a cross-country comparison of the PPP risks in the national PPP programs of three developing countries (Colombia, Kazakhstan, and Ghana) and provide insights into their best practices. Additionally, it aims to analyze the similarities and differences in risk factors in the selected countries. It suggests exemplary policy recommendations in delivering public infrastructure through programs in developing nations with similar PPP market profiles.

To achieve our purpose, we put forward the following research questions:

1. Are there significant differences in the perception of PPP risks within PPP programs in developing countries?
2. What are the most critical risk factors in developing countries with varying levels of PPP program maturity?
3. What are the practical implications of the study's findings for best practices in PPP programs in developing countries?

The contribution of this study to the PPP literature is three-fold: First, we performed a cross-country comparison of the risk factors in three developing countries, which is rare in the literature. Each of the three countries has its unique PPP market development path, ensuring risk analysis diversity. Second, our risk assessment questionnaire has 261 valid responses, representing the largest dataset in the PPP risk literature. The inductive and statistical analysis of such a representative number of responses allowed for a more plausible statistical generalization of the research findings. Third, the suggested implications will be useful for researchers and policymakers in delivering infrastructure PPP projects through innovation. They help better understand the inherent risks and complexity of the PPP market in developing countries.

2. Literature Review

Since the early 2000s, research on risk management in PPPs has grown dramatically, especially among studies from developing countries [13]. Bing et al. [20], investigating risks in PPP construction projects, combined 46 risk factors into 13 groups, comprising three meta-levels (macro, meso, and micro) of risk factors. The compiled risk register specific to PPP construction projects in the UK became the main data source of risks for further studies in multiple countries [21].

Wibowo and Mohamed [30], investigating the water supply projects in Indonesia, found significant risk factors and proposed a fair risk allocation between a regulator and operator. Sy et al. [23] studied risk factors for PPP transportation projects in Vietnam. The authors reviewed the literature and identified 38 risk factors for further interviews and surveys among the public and private sectors. All risks were analyzed and ranked, assessing 23 risk factors with a high risk level.

Other studies have explored PPP risks in China. Ke et al. [22] studied the risks in China's PPP projects and ranked the most significant risks, which included poor public decision making, political interference, financial risks, corruption, interest rate hikes, inflation, and a deficient legal system. Chan et al. [31] conducted empirical research in China on the detection of risks in PPPs and their distribution among PPP participants. A survey of 105 respondents who completed questionnaires revealed the most critical risk factors for Chinese PPP projects, such as political interference, public sector corruption, and poor decision making in the public sector. Ameyaw and Chan [3] have identified 40 risk factors for PPP projects in China's water supply sector. By interviewing experts, the authors compiled particularly critical risk factors, such as poor contract design, political interference, time and cost overruns, lack of experience in PPPs, wrong demand forecasts, financial risks, and conflict between the parties. In 2017, Osei-Kyei and Chan [21] conducted a risk survey among PPP experts in Ghana and Hong Kong and compared the risk factors as well as their impacts on PPP project success in the two countries. They found that different risk factors are critical for developing economies.

Research on risk management in the field, including on types of risk (e.g., financial, political, and project), continues to be a major topical research interest [5]. There is a significant consensus among scholars regarding the taxonomy of the most significant risk group factors for PPP projects, namely political and government, economic, legal, natural, construction, operational, and SPV-related. The taxonomy of risk factors for PPP infrastructure projects provides a comprehensive framework to understand and assess the various types of risks that can impact the success and sustainability of such projects. Each risk category holds specific relevance and implications, which are crucial for stakeholders involved in PPP projects to effectively identify, manage, and mitigate potential risks.

Political and government category group risks are related to changes in government policies, regulations, and political stability that can influence a project's feasibility and performance [11]. These risks include poor public decision making, political/public opposition, corruption, delay in land acquisition, and political interference. These risks can significantly impact the financial viability of a project, alter the risk allocation between public and private partners, and even lead to project termination. For investors and private partners, understanding and managing political as well as government risks are crucial in ensuring long-term success and protecting their interests.

Economic risks are associated with macroeconomic factors such as inflation, ex-change rates, interest rates, and economic downturns [21,32–34]. Fluctuations in economic conditions can affect project revenues, costs, and financing arrangements. Economic risks can impact project cash flows, debt servicing, and overall financial viability. Proper risk assessment and financial modeling are essential to anticipate and mitigate economic risks to maintain project stability and attract investors.

Legal risks encompass potential regulatory challenges affecting a project during the concession period [11]. Issues related to contract enforceability, ambiguous clauses, and contractual disputes can lead to costly litigation and project delays. Proper contract drafting, clear risk allocation, and dispute resolution mechanisms are crucial to managing legal risks in PPP projects.

Natural risks pertain to environmental impacts and force majeure events such as natural disasters and climate-change-related events that can disrupt project operations and cause physical damage to infrastructure [35]. For projects in vulnerable regions, such as coastal areas prone to hurricanes, adequate risk assessment and resilient design strategies are essential to mitigate natural risks and ensure infrastructure durability.

Construction risks are prevalent during the project development and construction phases [21,36]. These risks include cost overruns, delays in construction, poor workmanship, and design flaws. Construction risks can affect project timelines, budgets, and quality. Rigorous project planning, skilled contractors, and continuous monitoring are crucial in managing construction risks effectively.

Operational risks arise during the operational phase of the project and involve factors such as demand uncertainty, technological obsolescence, and operational disruptions [37]. These risks can impact project revenues, service quality, and long-term viability. Robust operational planning, maintenance strategies, and performance monitoring are essential to mitigate operational risks and ensure project sustainability.

SPVs are responsible for managing and operating PPP projects. SPV-related risks include issues such as financial distress, management inefficiencies, and conflicts between stakeholders [21]. The performance and financial stability of the SPV are critical for project success. Proper risk assessment, robust governance mechanisms, and stakeholder alignment are crucial in managing SPV-related risks.

In terms of methodologies, considering the frequency and influence of risks on project objectives, decision makers should perform risk quantification. One of the earliest quantification models focused on calculating the utility of weighted averages for potential outcomes in uncertain scenarios [38]. Today, expected utility theory is the most widely accepted model for quantifying risks. According to this theory, the probability impact model estimates a risk event by multiplying its impact by the probability of its occur-

rence [39]. Conversely, when the goal is not risk quantification but risk management, the most common methods are analytical hierarchy process, factor analysis, fuzzy set theory, Bayesian network, Monte Carlo simulation, and machine learning [13].

Despite the substantial amount of research that has explored the risk factors in PPP projects, the majority of these studies have concentrated on specific countries or types of infrastructure, thereby limiting their generalizability. Additionally, these studies often do not offer a comprehensive comparison of potential risk factors that may be common or different across various developing countries. Conducting an inductive analysis of these factors within specific nations could greatly enhance our understanding of PPPs globally, particularly for developing economies in different regions. To address these limitations in the existing literature, this study performs a cross-country comparison of PPP risks in developing countries and provides insights into their best practices. It also examines the similarities and differences in risk factors among the selected countries and offers exemplary policy recommendations for delivering public infrastructure projects in developing nations with similar PPP market profiles.

3. Methodology

We employed a mixed methods research approach using qualitative and quantitative data and methods. The approach was based on case study and statistical methods research [40,41]. On the one hand, it involved an in-depth qualitative analysis of PPP markets and narrowed it down to the selected case countries. Conversely, the study emphasized the breadth of the research findings and performed a statistical analysis of the survey results. Figure 1 presents the scope of the methodology in 6 stages with their descriptions, which are presented in the following sections.

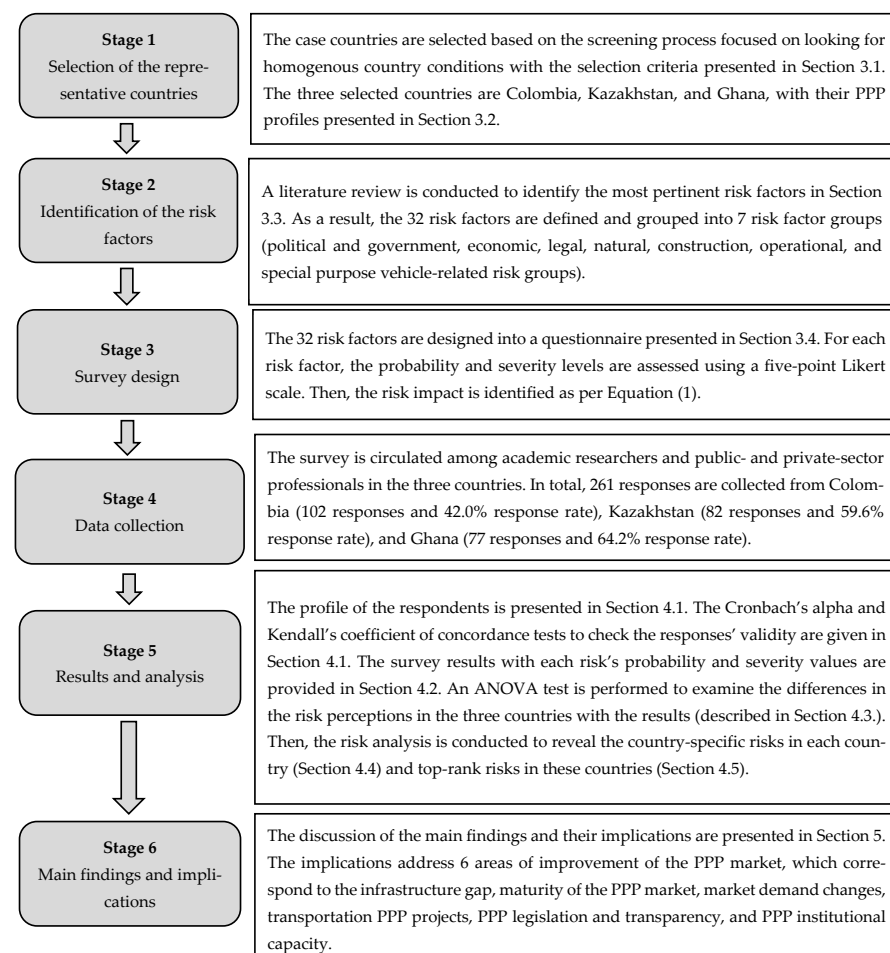


Figure 1. The research methodology.

3.1. Selection of the Representative Countries

To enhance the potential for generalization, this research conducted a systematic selection of representative jurisdictions for this cross-country analysis as opposed to the traditional practice of analyzing a single country. By selecting countries that meet these criteria, the study aims to provide a broader understanding of PPP risks and best practices that can be applied to other developing nations with similar profiles. The detailed criteria employed in the screening process are explained below followed by the relevant differences between these countries in terms of economic structures, political stability, cultural contexts, and legal frameworks.

This study concentrates on developing countries due to their increased vulnerability to crises and uncertainties compared to developed nations, which generally exhibit greater preparedness. To select the PPP programs for analysis, we exclusively targeted subregions comprising developing countries, excluding those (East Asia, Middle East, Oceania, Europe, and Northern America) containing developed nations. This process left only three regions for further consideration: Africa, Central/South Asia, and Latin America.

Once the subregions were identified, the screening process focused on looking for homogenous country conditions with the following selection criteria: First, we aimed at countries with homogeneous regulatory and institutional environments at a national level, typically unitary nations. Consequently, we removed federalist countries in Africa (e.g., Comoros, Ethiopia), Central/South Asia (India, Russia), and Latin America (e.g., Argentina, Brazil). Second, the analysis focused on countries with similar population sizes by removing countries with large populations. Larger population countries often have more complex governance structures, administrative challenges, and infrastructure needs that may affect the PPP program implementation and success. Therefore, countries with populations over 100 million were removed (e.g., Bangladesh, Egypt). The last filter was focused on screening mature PPP programs. As a result, only countries with programs initiated before the 2000s and still procuring projects after 2020 were considered, resulting in the exclusion of various countries in Africa (e.g., Algeria, Djibouti), Central/South Asia (e.g., Uzbekistan, Tajikistan,) and Latin America (e.g., Belize, Uruguay). Complementarily, we only targeted PPP programs involving the whole infrastructure sector arrangements considered by the World Bank for PPPs (energy, transport, water, solid waste, and ICT). Therefore, we also excluded programs with no water- or sewerage-related projects (e.g., Dominican Republic, Zimbabwe), solid waste treatment/disposal (e.g., Ecuador, Peru), or ICT projects (e.g., Sri Lanka).

After this screening process, the selected countries were Colombia in Latin America, Kazakhstan in Asia, and Ghana in Africa. Choosing the PPP programs in Colombia, Kazakhstan, and Ghana offers a broader and more diverse geographical perspective within mature PPP programs in developing countries.

Additionally, these nations share relevant commonalities, allowing comparisons between their PPP programs. They are middle-income developing countries with relatively high stability. Colombia is the fourth largest economy in Latin America (44th in the world) and the third most populated country in the region. Kazakhstan is the largest economy in Central Asia (54th in the world) and ranks as the second most populated country in that region. Ghana is the seventh largest economy and the tenth most populated country in its region [42].

Moreover, in terms of national PPP programs, the three countries have strong institutional environments, business climates, and financing markets [43–45]. Colombia is the top country in PPP regulations and the second in the PPP financing market in Latin America. Kazakhstan ranks as the top country in terms of the PPP institutions, business climate, and financing market in Central Asia according to the Infrascopes PPP index. Ghana ranks as the top country regarding business climate and financing in its region.

These countries have developed mature PPP markets, with many projects and substantial investment. Colombia initiated the first generation of its PPP program in the early 1990s, with Ghana doing so in the late 1990s. In comparison, Kazakhstan was the first

country to start a PPP program in Central Asia in the 1990s, with the rest of the countries in that region starting in the early 2000s [46]. These countries have also implemented comprehensive PPP legislation that enhances the legal framework for programs under scrutiny. Specifically, Law 1508/2012 in Colombia and the laws on public–private partnerships enacted in 2011 and 2015 in Ghana and Kazakhstan, respectively, provide contemporary and robust regulatory environments, contributing to the effectiveness of PPP practices in these countries [10,35,46].

The differences between Ghana, Colombia, and Kazakhstan offer rich insights into how distinct economic structures, political stability, cultural contexts, and legal frameworks influence risk perceptions and management strategies. By examining these variances, this study can identify unique risk factors and tailor best practices that account for these specificities.

In terms of economic structure, Ghana predominantly relies on agriculture and mining, which results in prioritizing transport and energy infrastructure to support these sectors. In contrast, Colombia has a diversified economy with significant contributions from agriculture, manufacturing, and services, resulting in a broader range of projects in transportation, urban development, and social infrastructure. Kazakhstan, on the other hand, is dominated by the oil and gas industry, resulting in emphasizing large-scale projects in energy and transportation to facilitate resource extraction and exporting.

In regards to the political and institutional environment, Ghana is known for its relative political stability and democratic governance, which positively influence investor confidence and the perceived risks associated with PPP projects. Colombia has a history of political instability and internal conflict, which can heighten the perceived risks of PPPs. Kazakhstan, on another hand, exhibits a more authoritarian political structure with centralized control, which can streamline decision making but may pose risks related to transparency and political changes.

In terms of cultural and social context, Ghana and Colombia are characterized by broad diversity, which may result in heterogeneous social acceptance and risk perception for PPP projects. Conversely, Kazakhstan is a post-communist nation with significant Russian influence, where ethnic relations and regional disparities can impact the perceived risks of PPP projects.

3.2. PPP Profiles of the Countries

3.2.1. Colombia

Table 1 provides general information from the World Bank for Colombia, Kazakhstan, and Ghana [46,47]. The implementation of PPPs in Colombia stemmed from a pressing need to address its infrastructure gap and limited public investment resources in the 1990s; therefore, the yearly investment in road infrastructure in Colombia was only 0.7% of GDP in the early 1990s compared to the 3% estimated for developing countries [48]. The Colombian PPP program was initially focused on seaport, airport, and road infrastructure. The institutional framework for PPPs in Colombia has evolved significantly, aiming to enhance risk allocation, streamline planning procedures, and introduce greater flexibility in PPP contracts while adhering to project finance principles. Despite these advancements, the Colombian PPP market continues to grapple with challenges in attracting international investors [48,49]. The Colombian PPP program encompasses more than 90 projects with a cumulative value of about USD 41 billion (Table 1). This PPP program is shaped by the regulatory framework established in Law 1508, bolstered by the support and involvement of the Inter-American Development Bank [50].

Overall, the Colombian public sector bears the responsibility to manage demand risks. Colombia's demand projections have been affected by optimism bias and errors. This bias has been particularly noticeable for PPP projects conceptualized between 2010 and 2014, during high GDP and increased commodity prices, such as that of oil. As a result, demand projects in Colombia tend to lead to potential discrepancies between expected and actual demand volumes [49,51,52]. Also, interest rates and inflation have historically been

controlled, but the exchange rate remains unstable. This aspect has been recognized as one of the main risks in PPP development [11]. Over the past decade, the exchange rate in Colombia has proved to be highly volatile, ranging from COP 1743.85 per US dollar to COP 5091.76 per US dollar, indicating a variation of almost 200% during this period. This risk is particularly relevant in developing countries, especially those heavily reliant on commodity-based economies.

Table 1. An overview of the key characteristics of Colombia, Kazakhstan, and Ghana.

Characteristic	Colombia	Kazakhstan	Ghana
Population, total (2021)	51,516,562	19,000,988	32,833,031
Surface area (thousands sq. km)	1140.6	2724.9	238.5
Population density (people per sq. km of land area)	45.9	6.9	141.4
Population growth (annual %) (2021)	1.1%	1.3%	2.0%
GDP (current USD)	314.46 billion	197.11 billion	77.59 billion
GDP per capita (current USD) (2021)	6104.1	10,373.8	2363.3
GDP growth (annual %) (2021)	10.7%	4.3 (%)	5.4%
Inflation, consumer prices (annual %)	10.2% (2022)	8.0% (2021)	10.0% (2021)
Total PPP investment (current USD)	41,654,726,000	2,563,060,000	7,473,000,000
PPPs investment in energy (current USD)	3,394,586,000	1,199,380,000	4,175,000,000
PPPs investment in transport (current USD)	36,666,760,000	1,222,000,000	2,060,000,000
Infrastructure ranking	81st	67th	118th
Macroeconomic ranking	43rd	60th	132nd
Market size ranking	37th	45th	65th
Business dynamism ranking	49th	35th	102nd

3.2.2. Kazakhstan

In Kazakhstan, PPPs were enacted in the early 2000s to attract private financing, build management capacity, and fill a niche in the infrastructure development gap [45]. As of 1 March 2022, there are PPP projects in the country valued at about USD 2.5 billion. Most of these projects are in the social sector, including education, healthcare (hospitals, sports, and recreation centers), housing, and communal services, and large-scale transport as well as road infrastructure projects. To stimulate PPPs, the state implemented several strategic initiatives; for example, under the initiatives of the Strategic Development Plan of the Republic of Kazakhstan until 2025 [53], the government not only modernizes the economic infrastructure with local and foreign partners but also creates competence centers to facilitate further industrial production.

Among the earlier studies that analyzed the success of PPPs in Kazakhstan was the study by Mouraviev and Kakabadse [54]. Based on a case study, they analyzed the distribution of risks in PPPs. They found that the government could shift most of the risks associated with management responsibility, financing schemes, and incentives for the timely completion of projects to private investors. Later, Mouraviev and Kakabadse [43] as well as Oinarov et al. [42] investigated risk factors in implementing infrastructure projects through PPPs in Kazakhstan. They concluded that the lack of innovation, public funds, the need to increase the attractiveness for private investors, the incentive for regional development, and increasing globalization are risk factors that the government of Kazakhstan should consider in developing local PPPs. Then, Tastulekov et al. [44] determined that inefficient methodologies for the economic evaluation of projects, inefficient regulatory frameworks, low-quality marketing research, and unreasonable economic estimations are risks that hinder the growth of the PPP market in the country.

3.2.3. Ghana

Private-sector participation in Ghana dates back to the early 1990s; however, the private sector's participation was only in managing and outsourcing public services in power production, water supply, and waste management [55,56]. Considering the increasing infrastructure deficit, the government of Ghana officially introduced the PPP concept to

deliver physical infrastructure, such as public housing, hospitals, roads, and seaports, through the launch of the PPP policy document in 2004; however, the PPP policy failed to be operationalized due to a lack of government commitment and political support [21]. In 2011, a new PPP policy was reintroduced to revitalize Ghana's PPP market. According to the World Bank [46], 31 large-scale PPP projects have been implemented, most of which are at different stages of development. These projects have a total investment amount of around USD 9.3 billion. Importantly, this demonstrates the steady development of Ghana's PPP market. Of the 31 PPP projects implemented in Ghana, 13 are from the energy sector. This outcome is not surprising because, since 1990, energy power production has been very attractive to private investors, and this is due to the low payment and revenue risks in this sector.

Few studies have analyzed Ghana's PPP market risks using different research approaches. Ameyaw and Chan [3] explored the critical risk factors in Ghana's water PPP sector through Delphi surveys. They found that the critical risks include corruption, inflation rate fluctuation, political opposition, and changes in market demand. Similarly, Osei-Kyei and Chan [21], through a questionnaire survey, identified corruption, exchange rate fluctuations, and inflation rate fluctuation as the top three risk factors in Ghana's PPP market. Considering that the PPP market in Ghana is still emerging, it is essential to continuously assess the risk factors compared to other countries to improve both local and international best practices.

3.3. Identification of the Risk Factors

Based on the review of the PPP literature, in general, and PPP risk literature, in particular, 32 risk factors were identified. To identify the risk factors through a comprehensive review, we followed the research approach previously discovered, recognized, and scientifically proven (e.g., [21]). Table A1 in Appendix A presents the selected risk factors frequently mentioned in the literature that are typical for PPP projects in developing countries. The table also provides the definition and impact of each risk, as well as source references. We classified the 32 risk factors into 7 risk factor groups: political and government (PG), economic (EC), legal (LG), natural (NT), construction (CN), operational (OP), and SPV-related (SP). Also, before running pilot and main surveys (introduced in Section 3.4.), an agreement analysis was conducted on the relevance of the 32 risk factors among the researchers involved in the current study, representing Colombia, Kazakhstan, and Ghana.

The PG risks are related to changes in government policies, regulations, and political stability that can influence a project's feasibility and performance [11]. These risks can significantly impact a project's financial viability, alter the risk allocation between public and private partners, and even lead to project termination. For investors and private partners, understanding and managing political and government risks are crucial in ensuring long-term success and protecting their interests [57]. The EC risks are associated with macroeconomic factors such as inflation, exchange rates, interest rates, and economic downturns. Such risks can affect project revenues, costs, and financing arrangements, leading to issues with project cash flows, debt servicing, and overall financial viability [16]. The LG risks encompass potential regulatory challenges affecting a project during the concession period [11]. Issues related to contract enforceability, ambiguous clauses, and contractual disputes can lead to costly litigation and project delays. Proper contract drafting, clear risk allocation, and dispute resolution mechanisms are crucial to managing legal risks in PPP projects. The NT risks pertain to environmental impacts and force majeure events such as natural disasters and climate-change-related events that can disrupt project operations and cause physical damage to infrastructure. The CN risks are prevalent during the project development and construction phases [4,36]. Construction risks can affect project timelines, budgets, and quality. Rigorous project planning, skilled contractors, and continuous monitoring are crucial in managing construction risks effectively. The OP risks arise during a project's operational phase and involve factors such as demand

uncertainty, technological obsolescence, and operational disruptions [27]. These risks can impact project revenues, service quality, and long-term viability. Finally, the SPV-related risks include financial distress, management inefficiencies, and conflicts between project partners. The performance and financial stability of the SPV are critical for project success. Proper risk assessment, robust governance mechanisms, and stakeholder alignment are crucial in managing SPV-related risks.

3.4. Survey Design

A structured survey was created to collect perspectives on the analyzed risks from individuals experienced with PPP projects in the selected countries. It aimed at three distinct groups of respondents engaged in PPPs within these nations: academic researchers as well as public- and private-sector professionals.

The survey consisted of 8 sections. The first section included questions about the respondents' personal and organizational information. The next 7 sections represented the 7 risk factor groups (Table A1 in Appendix A). Respondents were asked to evaluate each risk factor on two criteria: risk probability and risk severity. Each criterion was rated on a five-point Likert scale. The respondents were asked to rate the probability and severity levels of the 32 risks on a scale from 1 to 5, where 1 = very low; 2 = low; 3 = moderate; 4 = high; and 5 = very high. Assessing risks using these two criteria and scaling is the standard approach in the project risk management literature [30,58]. The Project Management Institute mandates using this risk assessment approach in practice. It defines the risk impact as an aggregate measure of the potential impact of all risks at any given time in a project [59]. The risk impact measure is equal to the square root of the product of the two measures, as per Equation (1):

$$Risk\ impact_i = \sqrt{Probability_i \times Severity_i} \quad (1)$$

where $Risk\ impact_i$ is the risk impact value for the i -th risk; $Probability_i$ is the mean probability value of all the responses for the i -th risk; and $Severity_i$ is the mean severity value of all the responses for the i -th risk.

The original version of the survey was kept in English for communication among the study authors in Colombia, Kazakhstan, and Ghana; however, for Colombia the survey was presented in Spanish, and in Russian for Kazakhstan. Based on the findings of the pilot study, the survey design was further refined, which involved improvements in its presentation in the two languages and making the survey statements clear.

3.5. Data Collection

In Colombia, a contact list of 243 potential respondents was developed. These experts possessed theoretical and practical knowledge of PPPs from consulting, PPP banking, and PPP public units. The authors followed up with some respondents through email and WhatsApp to enhance the response rate. In total, 243 invitations were sent out, and 102 completed surveys were received. The variation in the number of potential respondents in Colombia compared to Kazakhstan and Ghana can be attributed to the differences in the scale of their respective PPP programs. Colombia has undertaken more extensive PPP investment (USD 41.7 billion) than Kazakhstan (USD 2.6 billion) and Ghana (USD 7.5 billion) [46]. The effective response rate in Colombia was 42.0%.

Regarding Kazakhstan, a contact list of 141 respondents was prepared. These were state and private PPP center employees, bank consultants (providing financing for PPP projects), private companies involved in PPP, and private experts. Additionally, emails were sent to researchers with experience in PPP and private organizations involved in PPP consortiums. To increase the response rate, some respondents were also asked by email and WhatsApp. Phone calls were also made to available contacts with a polite reminder to take the survey. In total, 141 invitations were sent out. Many members of government entities refused to take the survey due to a lack of agreement from their senior managers. As a

result, 84 responses were returned (a response rate of 59.6%), and 82 were found complete and valid for the study.

For Ghana, a list of 120 potential participants was compiled, integrating individuals from Ghana Water Company Limited, the Public Procurement Authority, the Ghana Ports and Harbour Authority, metropolitan assemblies, the Ghana Investment Promotion Council, the Public Investment Division, the Urban Roads Department, the Ghana Highways Authority, SPVs, and academia. Out of the 120 invitations distributed, 77 completed questionnaires were collected, representing a response rate of 64.2%.

4. Results and Analysis

4.1. Profiles of the Respondents and Validity of Their Responses

The greatest number of experts who participated in the survey were from the private sector in Colombia and Kazakhstan, contrasting with Ghana, where the public sector had more representativeness, accounting for 47 (57.3%), 50 (49.0%), and 27 (35.1%) respondents respectively. Then, 22 (26.8%) public-sector respondents were in Kazakhstan, 42 (41.2%) were in Colombia, and 35 (45.5%) were in Ghana. The lowest number of survey participants was from the academic sector, with 13 (15.9%), 10 (9.8%), and 15 (19.5%) respondents in Kazakhstan, Colombia, and Ghana, respectively. A similar picture in the survey respondents was in the research of Ameyaw and Chan [3], where private-sector experts and consulting companies accounted for the majority (20.3% and 40.6%, respectively), the public sector amounted to about 28.0%, and academics represented only 10.9%.

The participants' years of experience were estimated from the global practice of considering experience in PPPs. Most respondents reported having less than 11 years of experience in PPP projects. The higher percentage of respondents in Kazakhstan (85.4%) that fell into this category can be attributed to the historical context, as Kazakhstan's PPP law was implemented relatively recently, in 2015. Additionally, PPP projects developed after the law's enactment account for 73% of the total capital investment in PPPs since the program's inception in the 1990s in this country. The second most prevalent experience category in the countries analyzed comprises respondents with 11–15 years of experience, representing 9.8% in Kazakhstan, 23.5% in Colombia, and 11.7% in Ghana. A smaller proportion of respondents had 16–20 years of experience (2.4% in Kazakhstan, 6.9% in Colombia, and 6.5% in Ghana) and more than 20 years of experience (2.4% in Kazakhstan, 6.9% in Colombia, and 1.3% in Ghana). These patterns reflect the evolution of PPP programs in each country. In Colombia, where PPP investment exceeded USD 1.4 billion for PPPs procured more than 20 years ago, the presence of professionals with significant experience is higher than in Kazakhstan and Ghana. In contrast, Kazakhstan has experienced a more recent surge in PPP development, with less than USD 0.5 billion invested in PPPs procured more than 20 years ago. See Table 2.

To examine the scientific validity of the survey responses, the study used a Cronbach's alpha test. This analysis was applied to assess the degree to which the probability and severity of risk factors are internally consistent [10]. The calculated Cronbach's alpha values exceeded 0.90 for probability and severity in the three countries, which is optimal considering that a Cronbach's alpha above 0.70 indicates strong internal consistency across all risk factors [60].

Second, Kendall's coefficient of concordance test was used as one of the common techniques in risk management [3]. It is a nonparametric rank correlation statistic used to measure agreement between responses and, in particular, reliability between responses. The coefficient was measured to estimate the experts' agreement. Moreover, the application of Kendall's coefficient yielded highly significant results with p -values < 0.001 for all of the countries analyzed. The significant p -values indicate a substantial degree of consensus among the participants in their evaluations, emphasizing the reliability and agreement in their assessments. See Table 3.

Table 2. Background of the respondents.

Characteristics	Colombia		Kazakhstan		Ghana	
	Number	Percentage	Number	Percentage	Number	Percentage
Sector						
– Practitioner (private)	50	49.0	47	57.3	27	35.0
– Practitioner (public)	42	41.2	22	26.8	35	45.5
– Academic	10	9.8	13	15.9	15	19.5
Experience						
– Less than 11 years	64	62.7	70	85.4	62	80.5
– 11–15 years	24	23.5	8	9.8	9	11.7
– 16–20 years	7	6.9	2	2.4	5	6.5
– More than 20 years	7	6.9	2	2.4	1	1.3
Total	102	100	82	100	77	100

Table 3. Statistical tests for the validity of the responses.

Characteristics	Colombia		Kazakhstan		Ghana	
	Probability	Severity	Probability	Severity	Probability	Severity
<i>n</i> (number of respondents)	102	102	82	82	77	77
Cronbach’s α -value	0.905	0.904	0.908	0.939	0.911	0.907
Kendall’s <i>W</i> -value	0.205	0.111	0.166	0.138	0.324	0.275
<i>p</i> -value (asymptotic significance)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

4.2. Summary Results of the Risk Factor Assessment

All 32 risks were assessed in terms of probability and severity, ranking the risk factors typical for Colombian, Kazakhstani, and Ghanaian PPPs. Table 4 presents the comprehensive results of the mean probability and mean severity values from the survey using a five-point Likert scale (described in Section 3.4.). Each of the 32 risks was assessed and grouped into the seven risk factor groups (as defined in Table A1 in Appendix A). Table 4 also reports the risk impact values computed by Equation (1) [59].

Table 4. The results of the risk factor evaluation.

Risk Factor Group	Risk Code	Colombia			Kazakhstan			Ghana		
		Prob.	Sev.	Imp.	Prob.	Sev.	Imp.	Prob.	Sev.	Imp.
Political and government	PG1	3.29	4.11	3.68	3.49	3.98	3.72	3.03	3.01	3.02
	PG2	3.64	3.94	3.79	3.02	3.32	3.17	3.23	3.51	3.37
	PG3	3.34	3.94	3.63	3.62	3.67	3.65	4.14	4.27	4.21
	PG4	3.62	3.81	3.71	3.41	3.66	3.53	3.14	3.27	3.21
	PG5	3.60	3.77	3.69	3.55	3.85	3.70	3.49	3.47	3.48
Economic	EC1	2.78	3.23	3.00	3.12	3.16	3.14	2.3	2.43	2.36
	EC2	3.61	3.80	3.70	3.98	3.98	3.98	4.13	4.16	4.14
	EC3	3.62	3.84	3.73	3.56	3.77	3.66	3.48	3.58	3.53
	EC4	3.80	3.93	3.87	3.99	4.04	4.01	3.96	3.96	3.96
	EC5	2.94	3.57	3.24	3.30	3.59	3.44	3.34	3.16	3.25
Legal	LG1	3.02	3.51	3.26	3.66	3.87	3.76	1.95	1.90	1.92
	LG2	3.20	3.48	3.34	3.26	3.57	3.41	2.75	2.81	2.78
Natural	NT1	2.84	3.57	3.19	3.00	3.52	3.25	2.3	2.56	2.43
	NT2	3.28	3.74	3.50	2.76	3.07	2.91	2.99	3.00	2.99

Table 4. Cont.

Risk Factor Group	Risk Code	Colombia			Kazakhstan			Ghana		
		Prob.	Sev.	Imp.	Prob.	Sev.	Imp.	Prob.	Sev.	Imp.
Construction	CN1	3.43	3.77	3.60	3.57	3.83	3.70	3.34	3.49	3.41
	CN2	3.52	3.92	3.72	3.83	3.98	3.90	3.27	3.38	3.32
	CN3	2.82	3.75	3.26	3.33	3.68	3.50	2.74	2.91	2.82
	CN4	3.49	3.87	3.68	3.54	3.89	3.71	3.36	3.43	3.40
	CN5	3.55	3.75	3.65	3.51	3.73	3.62	3.71	3.71	3.71
	CN6	2.51	3.33	2.89	2.88	3.22	3.04	2.49	2.68	2.58
	CN7	2.86	3.27	3.06	2.95	3.17	3.06	2.95	3.22	3.08
	CN8	2.44	3.08	2.74	3.12	3.49	3.30	3.04	3.13	3.08
Operational	OP1	3.06	3.38	3.22	3.30	3.51	3.41	2.56	2.52	2.54
	OP2	2.97	3.38	3.17	3.23	3.46	3.35	2.94	3.00	2.97
	OP3	2.84	3.15	2.99	2.94	3.17	3.05	2.75	3.00	2.87
	OP4	2.60	3.09	2.83	2.83	3.05	2.94	2.75	2.87	2.81
	OP5	3.25	3.79	3.51	3.35	3.68	3.51	3.06	3.00	3.03
SPV-related	SP1	2.85	3.18	3.01	3.07	3.30	3.19	2.79	2.88	2.84
	SP2	2.37	3.38	2.83	3.33	3.56	3.44	2.87	3.06	2.97
	SP3	2.91	3.40	3.15	3.15	3.52	3.33	2.78	2.94	2.86
	SP4	2.57	3.44	2.97	2.82	3.23	3.02	2.70	2.95	2.82
	SP5	2.69	2.76	2.73	2.70	2.98	2.83	2.56	2.53	2.55
Mean		3.10	3.56	3.32	3.29	3.55	3.41	3.03	3.12	3.07

Note: Prob.—probability, Sev.—severity, and Imp.—impact.

4.3. Statistical Analysis of the Risk Factor Groups

Before further analyzing specific and top-rank risks, we performed a one-way ANOVA test to examine the differences in the impact values between Colombia, Kazakhstan, and Ghana. An ANOVA is a method employed to examine the differences between the means of two or more groups (samples) [61]. Through this analysis, we check how much variation in the grouped data (country) comes from the differences between the groups (countries). The existence of this between-group difference would imply that there are statistically significant differences in the risk perception between the three countries. The assumptions for the ANOVA were that the respondent samples are normally distributed, have equal variances, and are randomly as well as independently drawn [61,62].

Earlier in this paper, in Section 3.2., we discovered the differences in the PPP market profiles of the countries. We noted that the differences were due to their development paths and maturity levels and political and government, economic, legal, natural, and SPV-related conditions. This finding came from our deductive investigation of the secondary data peculiar to the literature review and country report analysis of PPPs in the selected countries. On the contrary, with the ANOVA inferential statistics, we employ an inductive investigation of the primary data from the collected survey responses. With this inferential analysis, we expect to have the same finding, that is, to confirm the existence of the differences in the PPP market profiles.

We performed this analysis by the risk factor groups using the groups' mean impact values via Equation (1). Figure 2 presents the distribution of these values, which visually shows considerable differences.

The results of the ANOVA test are provided in Table 5. For each risk factor group, the sum of squares values shows the degree of variation in the risk perception between the three countries (between groups) and within a given country (within groups). For example, in terms of the between groups variation, the legal risk factor group has the highest sum of squares value of 67.5167 (which is visually shown with their impact value distribution in Figure 2). The degree of freedom corresponds to the number of respondents in the study survey. The *p*-values of each group are below the threshold value of the significance level of 0.05, which implies statistical significance. The *p*-values correspond to the *F*-statistic values

for each group, which are higher than the F -critical values (under the significance level of 0.05) [3]. Since the F -critical value corresponds to the significance level of 0.05, which is the same for all seven risk factor groups, its value is equal to 3.0307 for all of the groups. For all seven risk factor groups, the results are statistically significant. Based on this finding, we confirm the differences in the risk perception due to the PPP market profiles in the three countries. Consequently, we analyze specific and top-rank risks in the three countries in the next sections.

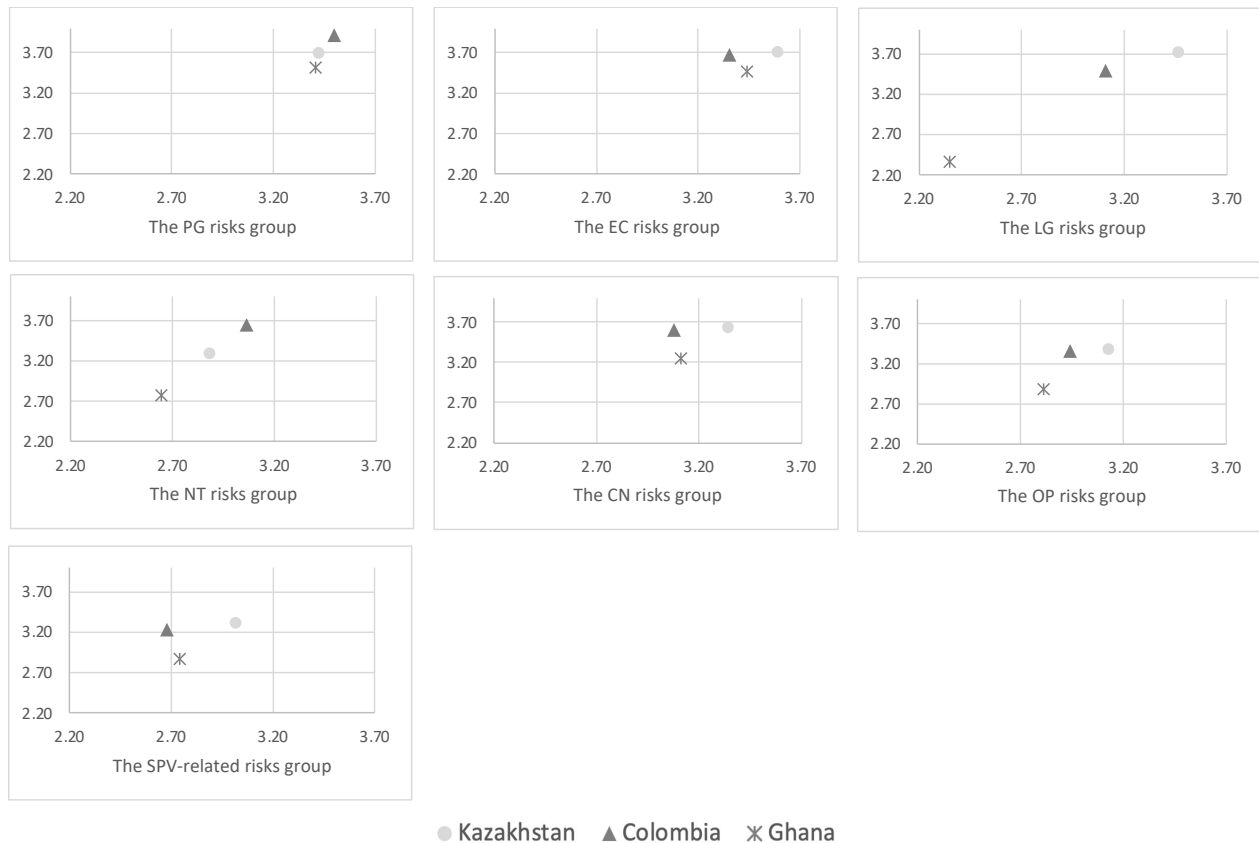


Figure 2. Distribution of the impact values of the risk factor groups of the three countries (where the x -axis—the probability of the risk factor group, and the y -axis—the severity of the risk factor group).

Table 5. The one-way ANOVA results for the differences in the risk impact values between the three countries.

Source of Variation	Sum of Squares	Degree of Freedom	Mean Sum of Squares	F-Statistics	p -Value	F-Critical
The Political and Government Risk Factor Group						
Between groups	2.4404	2	1.2202	3.8505	0.0224	3.0307
Within groups	81.7570	258	0.3168			
Total	84.1974	260				
The Economic Risk Factor Group						
Between groups	1.9274	2	0.9637	3.75513801	0.0246	3.0307
Within groups	66.2131	258	0.2566			
Total	68.1405	260				

Table 5. *Cont.*

Source of Variation	Sum of Squares	Degree of Freedom	Mean Sum of Squares	F-Statistics	p-Value	F-Critical
The Legal Risk Factor Group						
Between groups	67.5167	2	33.7583	62.4629	<0.0001	3.0307
Within groups	139.4372	258	0.5404			
Total	206.9539	260				
The Natural Risk Factor Group						
Between groups	18.0549	2	9.0274	17.4446	<0.0001	3.0307
Within groups	133.5135	258	0.5174			
Total	151.5685	260				
The Construction Risk Factor Group						
Between groups	4.0678	2	2.0339	7.1767	0.0009	3.0307
Within groups	73.1176	258	0.2834			
Total	77.1854	260				
The Operational Risk Factor Group						
Between groups	7.5223	2	3.7611	11.1469	<0.00001	3.0307
Within groups	87.0535	258	0.3374			
Total	94.5758	260				
The SPV-Related Risk Factor Group						
Between groups	6.0227	2	3.0113	7.2587	0.0008	3.0307
Within groups	107.0352	258	0.4148			
Total	113.0580	260				

The findings of this test signify that the risk perception by the PPP practitioners varies between the three countries. This variation can be attributed to the different development schemes in the PPP programs, which can be influenced by the analyzed risk factor groups. For example, for Colombia the risks due to the political and government and natural conditions are the most critical, while for Kazakhstan these two risk factor groups are less critical than the other five risk factor groups.

4.4. Specific Risk Factors Analysis

In terms of risk probability, the highest mean risk probability is in Kazakhstan (3.29), while in Colombia and Ghana it is lower (3.10 and 3.03, respectively) (Table 4). This disparity implies that PPP practitioners in Kazakhstan perceive a consistently higher risk level than their counterparts in the remaining countries. The heightened risk perception in Kazakhstan may be due to the specific risk factors within the economic (EC1—absence of competition), legal (LG1—legislation changes), and SPV-related (SP2—inexperienced private partner) groups. Interestingly, the probability assessed for these risk factors was much less significant in Colombia and Ghana. Generally, developing countries with less mature PPP programs, such as Kazakhstan, are characterized by lower overall investment and tend to display greater risk aversion.

Regarding the severity of risk factors, there were also noticeable differences between the three countries, indicating an even lower consensus in experts' perceptions (Table 4). Most of these differences are related to agreements between two out of the three countries. Less mature PPP programs (Ghana and Kazakhstan) demonstrated a higher rank in severity in three risk factors compared to the more mature program (Colombia): political interference, high financing cost, and delay in project completion. This may be explained by the fact that as the Colombian PPP program matured, the risk allocation of these risks succeeded in preventing side effects for other stakeholders, and there are clear contractual mechanisms to prevent disputes or renegotiations in this regard. Conversely, in upper-middle-income developing countries (Colombia and Kazakhstan), poor public decision

making was notably rated as having a higher severity. Therefore, the higher the GDP and GDP per capita in a developing country, the more detrimental the severity of the lack of capacity in public decision making. Conversely, more populated developing countries with higher PPP investment (Colombia and Ghana) rated political/public opposition and corruption as being more severe. The more populated and significant investment in PPPs of a country, the more detrimental effects are considered from politically driven risks.

Finally, in terms of the overall risk impact, the upper-middle-income countries (Colombia and Kazakhstan) depicted higher values (3.32 and 3.41, respectively) compared to lower-middle-income countries such as Ghana (3.07) (Table 4). This disparity implies that the lower the income level in a developing country, the less the impact experts consider when assessing risk factors affecting PPP megaprojects. Ghana had the worst global ranking in infrastructure (118th), macroeconomic factors (132nd), market size (65th), and business dynamism (102nd) when compared with Kazakhstan and Colombia [63]. Moreover, lower income developing countries with significant infrastructure and economic gaps perceived a much lower risk impact when developing PPP megaprojects due to the highest priority of addressing the gaps mentioned above through this project delivery. There were also noticeable differences in agreements between two of the three developing countries analyzed. Less mature PPP programs (Ghana and Kazakhstan) have demonstrated a higher rank in the severity of corruption and high financing costs. Experts in less mature PPP markets indicate that they still lack a PPP-enabling environment and macroeconomic conditions guaranteeing complete transparency and low financing costs. Conversely, in upper-middle-income developing countries (Colombia and Kazakhstan), poor public decision making was notably rated as having a higher impact driven by the perception of the severity of these risks for developing countries with higher GDP and GDP per capita. Conversely, more populated developing countries with higher PPP investment (Colombia and Ghana) rated political/public opposition and delay in project completion as having a higher impact, highlighting the detrimental effect of time underperformance and potential disputes.

4.5. Top-Rank Risk Factor Analysis

Table 6 presents the top 10 risk factors by the risk impact values. The ranking is based on the impact values of the risks calculated as per Equation (1) and reported in Table 4. For example, for Colombia, EC4 is ranked first and its impact value is 3.87 in Table 4, which is the highest. Some of these risks are common to all countries, while others are specific to one country only. Three risk factor groups led to this common agreement: PG, EC, and CN. Common EC risk factors within the top 10 risks in the three countries analyzed are related to fluctuation in inflation, interest, and exchange rates. Indeed, macroeconomic factors affecting financing and overall expenditures are relevant concerns in developing countries with increasing volatility, especially when dealing with global crises. Complementarily, the political/public opposition and corruption are also top concerns in Colombia (ranked the second) and Ghana (ranked the first), respectively. This implies a higher risk aversion regarding the social and political legitimacy of PPPs and land acquisition for PPP programs highly reliant on transportation infrastructure (88% of the total PPP programs) and highly populated countries, such as Colombia. Transportation projects such as roads and railways require land acquisition along hundreds of kilometers, increasing the potential issues in timely acquisitions. Moreover, impacted communities of transportation PPPs may involve diverse communities with heterogeneous interests that frequently may consider that there are more urgent necessities for their communities and may conceive the projects as detrimental, resulting in a greater erosion of social legitimacy. In Kazakhstan, project approvals and permit delays risk (ranked the third) greatly impacting the success of PPP programs.

Within the top 10 risk factors, risks are specific to one country only. Delays in land acquisition are the top-ranking risk specific to Colombia only, while they were not in the other two countries. Legislation changes are a unique top-ranked risk for Kazakhstan. This emphasizes that less mature PPP markets increase practitioners' risk perception of

the lack of stability in PPP-enabling regulation. Interestingly, the most mature PPP market (Colombia) was the only developing country that did not rank corruption within the top 10 risk factors.

In contrast, it was ranked as the first risk factor in Ghana and the tenth most relevant in Kazakhstan. This reflects that the more mature the PPP market and PPP-enabling legislation, the higher the transparency and the lower the corruption in this market. This is especially noticeable because, in Colombia, there have not been corruption scandals in PPP projects procured after the enhancements of PPP-enabling legislation made in 2012, contrasting with the scandals in PPPs in the early 2010s for PPP projects in which Odebrecht was involved within the SPVs. In this regard, the legislation and PPP-enabling environment promote competition and transparency in the Colombian PPP program.

Table 6. Top 10 risk factors in the three countries (ranked by the risk impact values).

Risk Group	Code	Risk Factor	Colombia	Kazakhstan	Ghana
Political and government	PG1	Poor public decision making	8	5	-
	PG2	Political/public opposition	2	-	9
	PG3	Corruption	-	10	1
	PG4	Delay in land acquisition	5	-	-
	PG5	Political interference	7	7	6
Economic	EC2	Inflation rate fluctuation	6	2	2
	EC3	Interest rate fluctuation	3	9	5
	EC4	Exchange rate fluctuation	1	1	3
Legal	LG1	Legislation changes	-	4	-
Construction	CN1	High financing cost	-	8	7
	CN2	Project approvals/permits delays	4	3	10
	CN4	Construction cost overruns	9	6	8
	CN5	Delay in project completion	10	-	4

5. Discussions and Implications

The study findings shed light on the impact of risk factors on PPP programs and punctuate the differences in risk perception across the developing countries in Latin America, Central/South Asia, and Africa. Policymakers and practitioners in the field can draw valuable lessons from the study and consider the following as policy recommendations in developing their PPP program agendas. The implications will also help enhance the performance of the PPP programs and bring innovation and technology into infrastructure development in emerging countries.

5.1. On the Infrastructure Gap

The findings revealed that lower income developing countries with significant infrastructure and economic gaps perceived a much lower risk impact when developing PPP megaprojects due to the highest priority of addressing the abovementioned gaps. In Ghana, the mean risk impact value was 3.07, compared to 3.32 in Colombia and 3.41 in Kazakhstan. Policymakers must recognize that the lower perception of risk impact in low-income countries does not necessarily mean that risks are absent or less relevant. Rather, it highlights the urgent need for a comprehensive risk assessment process that considers these countries' specific contexts and challenges. Moreover, given the lower perception of risk impact in these countries, there might be a tendency to proceed with PPP megaprojects without conducting thorough feasibility studies. This approach can lead to unforeseen challenges and project failures, considering the size and complexity of these projects. While addressing infrastructure and economic gaps is a priority, policymakers must balance urgency and risk management. Rushing into PPP megaprojects without adequate risk assessment and mitigation could lead to project delays, cost overruns, and subpar results. A measured approach that considers the urgency to address development gaps and the

need for risk management is vital. Governments should prioritize conducting comprehensive feasibility studies that assess project viability, risks, and potential long-term impacts; however, growing populations, rapid urbanization, and integration into global supply chains demand massive infrastructure in developing countries [64]. Governments should develop contingency plans and establish risk-sharing mechanisms to mitigate potential risks that may arise during a project lifecycle.

Policymakers in low-income countries may face challenges such as insufficient funding for comprehensive feasibility studies, a lack of expertise in risk assessment, and the urgency to initiate projects without thorough planning.

These challenges may be addressed by governments seeking technical assistance and funding from international development organizations to conduct detailed feasibility studies. Building local capacity through training and partnerships with experienced international consultants can improve risk assessment practices. Additionally, creating a balanced approach that considers both the urgency of infrastructure development and the need for thorough risk management is crucial. Implementing structured project management frameworks can help ensure that projects are well planned and that risks are adequately mitigated.

5.2. On the Maturity of the PPP Market

We found distinct risk aversion among the countries with PPP programs at varying stages of maturity. Less mature programs, with lower overall investment, tend to exhibit greater risk aversion and heightened concerns stemming from specific risk factors related to the absence of competition, legislation changes, and inexperienced private partners. The findings demonstrated that Kazakhstan exhibited greater risk aversion and heightened concerns related to specific risk factors like the absence of competition (EC1) and legislative changes (LG1). For instance, Kazakhstan showed greater concerns regarding legislation changes with an impact value of 3.76, compared to Colombia's 3.26 and Ghana's 1.92. PPP programs in incipient stages should use these findings to prioritize enhancing PPP legislation and promoting the creation of innovative PPP units in these countries while regulating sensitive matters such as unsolicited proposals. Overall, well-regulated PPP markets have been demonstrated to be a key factor in attracting private companies, increasing competition, and transferring innovative experience to local companies.

Policymakers in less mature markets may struggle with developing and enforcing comprehensive PPP legislation, fostering a competitive environment, and attracting experienced private partners. To address these challenges, policymakers should prioritize the development of clear and stable PPP legislation, with input from both public- and private-sector stakeholders to ensure that it meets market needs. Creating dedicated PPP units with specialized knowledge can help manage and oversee PPP projects effectively. Encouraging international firms to enter the market can increase competition and bring in best practices. Providing incentives for local firms to partner with international companies can also help build local expertise and improve the quality of PPP projects.

5.3. On Market Demand Changes

Lower-middle-income developing countries demonstrated a higher risk aversion to changes in market demand. Ghana demonstrated the highest risk aversion to changes in market demand. For instance, Ghana's risk impact value for economic fluctuations (EC2) was 4.14, contrasting with Kazakhstan's (3.98) and Colombia's (3.70), indicating significant concerns about market demand variability and its implications on user revenues. The public sector in these countries may use this finding to enhance the availability of liquidity guarantees to address potential cash shortfalls derived from lower user revenues. Collaborating with development financial institutions or establishing reserve accounts that can be accessed during times of crisis can provide suitable mitigation alternatives. Diversifying revenue sources for PPP programs is also essential to reduce funding dependence on user revenues, which are particularly vulnerable to global crises. Therefore, exploring alterna-

tive revenue generation models, such as value-capture mechanisms or innovative financing structures, can enhance the resilience of PPP programs in times of crisis. For example, SPV partners can model adequate payment mechanisms, financial penalties, and government guarantees, considering their strategic objectives in a game-theoretic framework during the project feasibility and planning stages [65].

These measures can be challenged by the volatility of market demand, limited financial reserves to manage revenue shortfalls, and the risk of underutilized infrastructure projects. For addressing these challenges, policymakers should enhance the availability of liquidity guarantees and establish reserve accounts that can be accessed during times of crisis. Collaborating with development financial institutions can provide additional financial support. Diversifying revenue sources through value-capture mechanisms or innovative financing structures can reduce dependency on user fees. Implementing flexible project designs that can adapt to changing demand conditions and regularly reviewing project assumptions can also help mitigate these risks.

5.4. On Transportation PPP Projects

There is a higher risk aversion in highly populated countries with more mature PPP programs that rely more significantly upon transportation infrastructure regarding the social and political legitimacy of PPPs and land acquisition for PPPs. Colombia showed the highest risk aversion regarding the social and political legitimacy of PPPs and land acquisition issues. In Colombia, political/public opposition (PG2) had an impact value of 3.79, contrasting with 3.17 in Kazakhstan and 3.37 in Ghana, and delays in land acquisition (PG4) were ranked fifth with an impact value of 3.71, contrasting with 3.53 in Kazakhstan and 3.21 in Ghana. Transportation projects such as roads and railways require land acquisition along hundreds of kilometers, increasing the potential issues of timely acquisitions because of the diverse communities with heterogeneous interests that frequently result in a greater erosion of social legitimacy. Responsible stakeholders in those countries may use this study's findings to foster cooperation, transparency, better alignment between stakeholders' objectives, and mutual accountability among internal and external stakeholders to enhance the social sustainability and resilience of transportation PPP projects. This will boost the smart infrastructure environment and accelerate sustainable development practices in the PPP markets [66].

Policymakers may face challenges related to community resistance, complex land acquisition processes, and coordination among diverse stakeholders. Addressing these challenges requires enhancing stakeholder engagement through transparent communication and inclusive decision-making processes, which can help build trust and reduce opposition. Implementing fair and efficient land acquisition policies and ensuring adequate compensation for affected communities can mitigate resistance. Establishing clear procedures and timelines for land acquisition and involving all relevant stakeholders early in the planning process can streamline coordination and prevent delays.

5.5. On PPP Legislation and Transparency

This study demonstrated that the lesser the maturity of the PPP market and the PPP-enabling legislation, the greater the experts' concerns regarding the transparency and corruption of this market. In Ghana, corruption (PG3) was ranked first with an impact value of 4.21, while in Kazakhstan it was ranked tenth with an impact value of 3.65, and in Colombia it was not even in the top 10 (with an impact value of 3.63). In this regard, less mature PPP markets in developing countries should prioritize enhancing legislation and the PPP-enabling environment to promote competition and transparency. The combination of competition and transparency at the tendering stage reduces public officials' discretion and may diminish the value of bribes. Improved financial disclosure for companies operating in international bond markets also limits their ability to generate funds for bribes. Competitive tendering and transparency requirements in PPP programs within developing countries are not coincidental but rather the result of multilaterals' and academics' insistence on

open and competitive auctions for infrastructure projects. The disclosure of information on contract renegotiations should be made easily available to the public, and an independent panel of experts should review renegotiations. Additional works should be tendered in open auctions, excluding the initial contract-winning firm, to increase the government's bargaining power and reduce rents from renegotiation.

Challenges to implement these recommendations include entrenched corruption practices, a lack of transparency in procurement processes, and the weak enforcement of anticorruption measures. To address these challenges, policymakers should prioritize the enhancement of PPP legislation to include stringent anticorruption provisions and ensure transparent procurement processes. This can be achieved through competitive tendering, improved financial disclosure, and public access to information on contract renegotiations. Establishing an independent panel of experts to oversee and review the procurement process can help ensure fairness and transparency. Regular audits and strict penalties for corrupt practices can also deter corruption.

5.6. On PPP Institutional Capacity

Lastly, the findings exhibit that the higher the GDP and GDP per capita in a developing country, the more detrimental the impact of a lack of capacity for public decision-making issues and politically driven risks. For instance, poor public decision making (PG1) had higher impact values in Colombia (3.68) and Kazakhstan (3.72) compared to Ghana (3.02). Public-sector decision makers in these countries require building specialized institutional capacity for undertaking PPP projects and developing a PPP program. Establishing innovative PPP units has become common to ensure sufficient governmental capacity. Moreover, this capacity is not solely confined to the PPP unit but requires being distributed across the broader PPP-enabling field, comprising supporting organizations. Government departments must also develop the capacity to understand performance specifications, risk transfer, and PPP financial objectives better while providing training as well as support and publishing guidance materials to enhance the capacity of various governmental departments. Complementarily, successful PPP programs also require innovative capacity building in the private and social sectors, which may involve providing various forms of support (e.g., governmental guarantees). Furthermore, enhancing the capacity of social sectors can involve promoting norms of information sharing and participation in decision-making processes, objective and independent media, voluntary associations, and nonprofit organizations. Transparent and inclusive decision-making processes are essential for garnering support from various stakeholders, including the public, investors, and international partners. Engaging with stakeholders throughout the project lifecycle can help identify potential risks, build trust, and ensure a project's sustainability.

Policymakers may face challenges in building the necessary institutional capacity, attracting skilled personnel, and ensuring effective coordination among different government departments. For addressing these challenges, the building of specialized institutional capacity involves establishing dedicated PPP units with trained staff who can manage and oversee PPP projects effectively. Providing continuous professional development and training opportunities for public officials can enhance their understanding of PPP processes and best practices. Implementing knowledge-sharing platforms and engaging with international experts can also help build local capacity. Ensuring effective coordination among government departments through clear roles and responsibilities, along with regular interdepartmental meetings, can improve project implementation and decision making.

6. Conclusions

Governments enter into PPP agreements to attract private financing for capital expenditures and bring innovation as well as technology to develop their public infrastructure; however, PPP projects are characterized by their complexity and long-term nature, driven by uncertain economic and institutional environments. This study conducted a cross-country comparison of the PPP risks in three developing countries (Colombia, Kazakhstan,

and Ghana) and provided insights into their best practices. Our risk assessment questionnaire included 261 valid responses, representing the largest dataset in the PPP risk literature. The inductive and statistical analysis of such a representative number of responses allowed for a more plausible statistical generalization of the research findings.

The research findings revealed essential differences in risk perception and impact among the countries, driven by varying political, economic, legal, natural, construction, operational, and stakeholder-related contexts. The implications of the study address the infrastructure gap, maturity of the PPP market, market demand changes, transportation PPP projects, PPP legislation and transparency, and PPP institutional capacity. Overall, they will be helpful to policymakers and practitioners in enhancing their PPP program agendas, including risk assessment practices, public decision making, success and sustainability, and transparency and stakeholder engagement.

This study makes substantial theoretical contributions to the PPP literature by elucidating the relationship between PPP market maturity and risk perception. More mature PPP markets have developed sophisticated mechanisms with which to mitigate risks, including well-defined legal frameworks, experienced stakeholders, and established risk-sharing practices. As a result, the perception of risk is more nuanced and focused on managing residual risks effectively. In countries with mature PPP programs, regulatory stability contributes to a lower perception of legal and political risks, while in small PPP markets the evolving regulatory landscape heightens the perception of these risks due to uncertainty and a lack of precedents. Mature markets with strong institutional frameworks perceive lower operational risks due to better project management capabilities.

Despite the valuable insights provided, this study has limitations that should be acknowledged. Firstly, the research was conducted in specific developing countries, and the findings may not be fully generalizable to other developing nations. Each country has unique socioeconomic, political, and cultural contexts, which can significantly impact risk perception and management in PPP programs. Future studies should expand the research to include a more diverse sample of developing countries to enhance the applicability of the findings. Secondly, the survey-based methodology used in this study relies on the perceptions and opinions of experts involved in PPP projects. While this approach provides valuable qualitative data, it may be subject to bias and subjectivity. Future research could complement survey data with objective performance metrics from actual PPP projects to strengthen the robustness of the findings. Alternatively, more nuanced risk assessment methods, such as a decision tree, Monte Carlo simulation, sensitivity analysis, regression analysis, or partial least squares structural equation modeling, can be used in the future. These methods can better account for uncertainties and dependencies between risk factors, should the focus be on investigating dependencies between the risks. Lastly, the study focused on PPP programs in Latin America, Central/South Asia, and Africa; however, risk factors and management practices may differ significantly in other regions, such as Southeast Asia, the Middle East, or Eastern Europe. Including more countries from different regions would provide a more comprehensive understanding of the global risk perception and management variations in PPP projects. Lastly, this paper focused on analyzing general risks affecting mature PPP programs. Future research can focus on the impact of specific recent crises (e.g., COVID-19, wars) on PPP programs (e.g., [32,67]) and offer suitable strategies for tackling these effects.

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Appendix A

Table A1. Selected risk factors in PPPs.

Risk Factor Group	Risk Code	Risk Factor	Definition and Impact
Political and government	PG1	Poor public decision making	Success of PPPs depends on sound public decision making. Poor decisions of the public sector can lead to unfavorable outcomes for the partnership
	PG2	Political/public opposition	Political and public opposition to PPP projects can disrupt or even derail them. A negative public perception or lack of support can lead to delays, changes in the project scope, or even project cancellations
	PG3	Corruption	Corruption in PPP projects can result in inflated project costs, substandard work, and lower quality outcomes. It can also damage the reputation of private-sector partners and lead to legal implications
	PG4	Delay in land acquisition	Delays in land acquisition can hold up PPP projects and lead to significant cost and time overruns. Such delays can be due to difficulties in acquiring land for construction due to opposition from owners or legal regulations
	PG5	Political interference	Undue government intervention and pressure in a PPP project can result in project delays, changes in project scope, and lower quality outcomes
Economic	EC1	Absence of competition	Poor procurement processes and the absence of competitors can lead to inefficient project execution, increased costs, and lower quality outcomes
	EC2	Inflation rate fluctuation	Fluctuations in the inflation rate can impact the financial sustainability of the project, particularly in projects with long construction and operation periods
	EC3	Interest rate fluctuation	Interest rate fluctuations impact the financing cost of PPP projects, affecting a project's financial viability
	EC4	Exchange rate fluctuation	Fluctuations in exchange rates impact the financial sustainability of PPP projects that involve foreign currency
	EC5	Change in market demand	Excessive user fees or the availability of an alternative option negatively affect demand and consequently the return on investment

Table A1. Cont.

Risk Factor Group	Risk Code	Risk Factor	Definition and Impact
Legal	LG1	Legislation changes	Changes in legislation can impact the regulatory environment of PPP projects, leading to project delays or changes in the project scope
	LG2	Tax regulation change	A change in the tax rate can change the estimated revenues and the payback period of a project
Natural	NT1	Force majeure	Natural disasters or other events beyond the control of the parties involved can disrupt or delay PPP projects, resulting in additional costs
	NT2	Environmental risk	Negative effects caused by construction, impacts, and changes in the environment may lead to public protest, leading to the suspension or redesign of a project
Construction	CN1	High financing cost	The high-interest rate of borrowed funds may lead to an increase in the cost of the project, the return period of the investment, and an increase in the tariff
	CN2	Project approval and permit delays	Delays in obtaining project approvals and permits due to bureaucracy and a weak state apparatus can hold up PPP projects and lead to significant cost overruns
	CN3	Design deficiency	Design deficiencies can lead to lower quality outcomes, delays, construction changes, and additional costs
	CN4	Construction cost overruns	Construction cost overruns arising from incorrect estimates, design changes, and economic instability can impact the financial viability of PPP projects
	CN5	Delay in project completion	A prolonged construction process due to difficulties with manpower, expertise, and a lack of equipment or material can result in the postponement of the completion of the PPP project
	CN6	Unavailability of labor and material	An unavailability of labor and material can impact the construction phase, resulting in delays and cost overruns
	CN7	Construction changes	Changes in construction design can result in delays, additional costs, and lower quality outcomes
	CN8	Poor quality of workmanship	A poor quality of workmanship can lead to lower quality outcomes, additional costs, and legal disputes
Operational	OP1	Operational cost overruns	Unplanned increases in operating costs caused by incorrect scheduling, forecasting, or technological changes can impact the financial viability of a project
	OP2	High maintenance cost	Excessive facility maintenance costs can impact the financial viability of a project

Table A1. Cont.

Risk Factor Group	Risk Code	Risk Factor	Definition and Impact
SPV-related	OP3	Change in technology	Technological changes in the operational phase of a project may require changes to the designs and result in additional costs
	OP4	Project operation changes	Changes in the operational phase caused by improper design may result in poor quality, design modifications, and additional costs
	OP5	Tariff change	Changes in tariffs can impact the financial sustainability of user-pay PPP project
	SP1	Third-party liabilities	Third-party liabilities, such as accidents, damages, or other legal disputes involving third parties, can impact the financial viability and reputation of a PPP project
	SP2	Inexperienced private partner	An inexperienced private partner may lack the necessary skills, knowledge, and experience to deliver a project successfully, leading to lower quality outcomes, project delays, and additional costs
	SP3	Conflict between partners	Interests, practices, and strategies of private partners and public entities in PPP projects may differ, which can lead to project delays and legal disputes
	SP4	Lack of commitment from project parties	Lack of commitment from government and investors can lead to project delays, lower quality outcomes, and legal disputes
	SP5	Changes in shareholdings of the consortium	Changes in shareholdings of the consortium can impact the governance and decision-making processes of PPP projects

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