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Mitigating Financial Risks in Sustainable Public–Private Partnership Infrastructure Projects: A Quantitative Analysis

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Abstract: Economic recession from the coronavirus outbreak continues to have negative rippling effects on local and international financial investments in public–private partnership (PPP) projects in Ghana, a developing country. Together with poor reports on operating cash-inflows for PPP projects such as those covering schools, hospitals, railways, fishing harbors, cocoa warehouses, recreational parks and affordable housing, there is an urgent need to develop and institutionalise sustainable and robust financial risk management measures. These measures are meant to mitigate financial losses, promote sustainability practices and prolong the longevity of infrastructure developments within PPP pacts. Therefore, this study aims to assess the mitigation measures of PPP infrastructure management in Ghana. Primary data from survey questionnaires were utilised in this study, with the data obtained from PPP practitioners and experts. Data were grouped into project type, sectors and practitioners of PPP projects to aid the analysis using tools such as the Kruskal–Wallis test, the Mann–Whitney U test and factor analysis. The results demonstrate sustainable and green finance, the innovative skills and competencies of project teams, green financial risk models and inclusive cost reduction strategies as crucial to minimising financial risks in PPP project delivery. These findings have significant implications for PPP practitioners and researchers in Ghana and similar developing countries to understand and develop measures to respond to financial risks for sustainable PPP project development and future research studies.

Keywords: financial risks; sustainability; infrastructure development; questionnaires; PPP projects

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1. Introduction

Public–private partnership (PPP) is rapidly becoming the preferred procurement method for sustainable project development in the 21st century [1,2]. PPP pools the resources of private entities and the public sector together in the delivery of projects and services such as schools, hospitals, recreational parks, light rails, airports, affordable houses, agricultural produce and COVID-19 vaccines [3]. The private sector largely bears the financial risks in the design, construction and management of the project. Also, private investors pay for the financial liabilities of feasibility studies, maintenance, transfer costs and decommissioning expenses of the project within a concession period [4]. The public sector, including the national (federal) and state governments, districts, councils and public institutions, assumes the risks of the facilitation and supervision of project delivery [5]. Accordingly, a critical risk factor in value-for-money in PPP project execution is financial risks. The financial risks of PPP projects refer to the financing challenges (inability to attract enough capital to initiate the project) and operational losses (recording more project costs than revenue) as well as mismanagement of project funds and corrupt practices that siphon investment capital and revenues [6]. The outbreak of COVID-19 worsened the financial stance of PPP projects, resulting in a reduction in financial investment in PPP projects. According to the World Bank, the pandemic put a cap on the capital injection into PPP projects with a decline in financial investments of 52% from $96.7 billion to $45.7 billion [7,8].

These problems created a cashflow crisis for operators of the PPP infrastructure, especially in developing nations like Ghana [9]. The pandemic delayed the completion of the Pokuase road interchange project in Accra and twenty-two (22) hospitals across the country, creating additional expenditure for these PPP infrastructure projects [10,11].

Furthermore, recent data from the World Bank and climate reports have reported rising cases of disasters from extreme weather changes which have resulted in the financial loss of over AUD 4.3 trillion together with deaths and the destruction of infrastructure projects in Ghana [12,13]. These unfortunate climate change incidents undermine sustainable infrastructure development and increase the cost of repair for PPP infrastructure [14,15]. For instance, the Accra–Cape coast road and Tema motorway linking the three major cities of Accra, Tema (industrial hub) and Cape Coast have experienced infrastructure being washed away and potholes due to persistent rainfall. These incidents have increased the maintenance costs of the roads, leading to additional loans being secured to redevelop the projects. Additionally, Boateng [16] mentioned that twenty (20) key affordable residential houses and multi-story commercial buildings collapsed in Ghana between 2000 and 2020 due to increased climate hazards such as flooding and strong winds. The financial costs associated with revamping these collapsed PPP infrastructures were huge in addition to compensating families who lost their loved ones in the collapsed building incidents. Moreover, most of the recreational centres under PPP contracts in Ghana are in a depilated state because of weather changes [17,18]. Existing recreational centres have a poor maintenance culture due to financial challenges (limited funds for renovation) [19]. Furthermore, little progress has been made in the reduction of carbon emissions from the inclusive management of infrastructures in PPP contract arrangements in the Ghanaian economy [20]. Also, the lack of disability-friendly features in most PPP infrastructure developments in the country is worrying, with most infrastructures failing the inclusion tests of development for those in the disability community [21]. With the promulgation of the Persons with Disability Act (2006) in Ghana, existing public buildings within PPP arrangements at the national and local levels are supposed to be retrofitted to disability-friendly status at extra project costs. Failure of project managers to meet these disability accessibility regulatory requirements also result in fines and financial charges to the project management organisations [22]. Moreover, the inclusion of sophisticated smart and technology-inspired PPP infrastructure features to assist the disabled and aged in Ghanaian society add up to the construction and operational costs [20,23]. To address these challenges, this study assesses the mitigating strategies for financial risks in sustainable public–private partnership infrastructure projects in Ghana.

The novelty of this research includes the presentation of guidelines of measures critical in financial risk management for practitioners to develop practical project policies and practice models. It is the first of its kind from Ghana with measures to guide the mitigation of financial risks using empirical data from PPP practitioners in the country. The practice guidelines on financial risk management will be instrumental in fostering infrastructure development in the country. The checklist of financial risk mitigation measures is relevant for future studies and theoretical development in PPP research. The outcomes will enrich the existing literature and scholarly investigations into measures addressing financial challenges in attaining sustainable PPP infrastructure projects from a developing economy perspective. The section afterward is a review of the literature followed by the research methodology. The results and discussions come next with conclusions at the end of the article.

2. Literature Review

2.1. PPP Concept

The concept of public institutions collaborating with private entities to provide services and infrastructures under public–private partnership (PPP) agreements has been around for centuries [24]. The concept was well publicised in the Roman Empire, and it was used in building and expanding highway networks. PPP was common in the delivery of postal

letters and the operation and transportation of farm produce and military mercenaries to fight opponents [25]. This gave birth to the "manceps" model, which allows competitive tendeIring and bidding to allow the private sector to be involved in public projects. During the Middle Ages, the PPP concept was instrumental in the development of fortified ports and towns in Europe against reprisal attacks from invading adversaries [26,27]. In the industrial revolution era, the rapid development of towns into cities and the emergence of new technologies from private inventors and organisations brought the government and the private sector together [28]. While the government has made laws to protect the intellectual property rights of private entities, these private corporations contribute to the supply of technology, jobs and consumables to the public to ease the pressures on governments [29,30]. In the latter part of the 20th century, the United Kingdom (UK) government rebranded these public–private collaborations under the term Public Finance Initiatives (PFIs). The PFI model has been seen in the delivery of major infrastructure projects across the UK, and it is the precursor to the modern PPP models around the world [31]. Examples of PPP infrastructure projects include the Sydney Harbour Tunnel (Australia), Abbotsford Hospital (Canada), Shantou Coastal New Town Project (China), Underground Tunnel projects in London (UK) and California Fuel Cell Partnership projects (United States). In PPP arrangements, a concessionary period is allowed to finance, build and operate, after which the project will be transferred to the owner (in most cases, the public sector) [32]. The key partners of the public sector and private corporations share risks and benefits from the projects based on the terms and conditions agreed upon in PPP contracts [7,33].

2.2. PPP Arrangements in Ghana

Public–private partnership (PPP) arrangements have become prominent in Ghana's socio-economic development, dating back to the 1990s within the fourth republic constitution era [19]. The preceding events that sparked the acceptance of the private sector in the public space are the various Economic Recovery Programs (ERPs) and Structural Adjustment Programs (SAPs) in the 1980s [34]. These programs encouraged the privatisation of state-owned enterprises constructed under the first republican government of the country [35]. Fast-forward, in the 2000s, the government of Ghana formalised PPP initiatives with the creation of the Ministry of Private Sector and Presidential Special Initiatives [19]. The goal of this governmental arm was to solicit the support of private investors within Ghana and overseas to provide services and construct infrastructures for the country. In the 2000s, a document was drafted and issued by the government to assist in the administration of PPP contracts in the country [36]. However, this document lacked parliamentary support as it was not comprehensive enough to cover important contract administration issues within PPPs. As part of the course of governance history in the country, in the 2010s (2010–2019), the Ghanaian government introduced another policy to guide the operation of PPP activities, and the presidency became actively involved in its administration by attaching PPP issues to the Ministry of Finance and Ministry of Planning [37]. The PPP national was relaunched to support the evaluation and monitoring of projects with the support of private finance. The cabinet of Ghana approved a bill, and it was introduced to parliament in 2015 to begin the formal passage of a statutory law guiding PPPs [35,38]. Upon deliberations and changes to the bill, it received presidential assent into law in 2020 (Public Private Partnership Act 1039 [36,39]). Within the PPP Act, the concept and localisation of PPP terminologies are outlined together with the responsibilities of the various stakeholders. In Ghana, PPP contract risks including financial burdens are borne by private investors. Pressing areas of infrastructure development such as water, road networks, housing, power (electricity) and school buildings have seen the operation of PPP contracts [40]. Infrastructure projects such as the redevelopment of Kojokrom market, water treatment plants in the Asutsuare, Tema and Pokuase interchanges and Ofankor health center were built within the PPP arrangements [35]. In the 2020s, the attention of PPP arrangements has shifted to building more sustainable, low-carbon and renewable

projects to solve the country's socio-economic development challenges in different regions of the country [41].

2.3. Sustainable PPP Infrastructures

In the delivery of public infrastructures, the PPP arrangement has been noted as playing a significant role in the attainment of the United Nations Sustainable Development Goals (UNSDGs) [42]. Goal 17 (Partnerships), Goal 13 (Climate Action) and Goal 11 (Sustainable cities and communities) are some of the examples of UNSDGs that form the foundation of the construction and management of sustainable PPP infrastructures [43]. Sustainability in PPP infrastructures stem from the quest to champion social inclusivity and diversity of cultures, resolve the climate crisis and protect environmental resources for future, unborn generations in addition to economic prosperity [44]. Cheng et al. [45] mentioned sustainability in PPP infrastructures from the longevity of buildings and maintaining projects to fulfil their purpose to advance social progress and desired outcomes for non-profit state partners. Sustainability within the context of PPP projects also goes beyond the three triangles of project management, cost, quality and time, integrating social, economic and environmental dimensions of development [46]. The social dimension of PPP infrastructures can be explained by the less or no-profit orientation of the project to support communities and the disadvantaged in society. This includes infrastructures that have a high propensity to contribute to social advancement and change of lifestyles through the provision of jobs, affordable transport and houses as well as social support networks [41,47]. As a partner in the PPP infrastructure, the public sector ensures that this is achieved through regulations and good governance structures [39]. Efforts regarding the environmental sustainability of PPP projects are seen in measures to mitigate the climate crisis which is not helpful to the survival of PPP projects. PPP infrastructures also contribute to the release of an enormous amount of emissions into the atmosphere, which deepens climate change challenges [48,49]. PPP infrastructures such as road construction utilise fossil fuel products and account for more than 30% of carbon emissions. Measures to transition to more sustainable and lower to zero carbon PPP contracts are being supported with legislations and policies in many countries [14].

2.4. Financial Risks of PPP Infrastructure Projects

Financial risks are major obstacles to sustainable project transition and success [50,51]. In public–private partnership-sponsored infrastructure projects, Aladağ and Işik [4] explained that financial risks arise from poor operational models in financial management worsened by external economic challenges of interest and inflation rate fluctuations, the default of loan repayment and failure to meet revenue targets. Forms of financial risk exist in different projects depending on the capital structure, risks and the state of operating controls. Outside the confines of the projects are market risks comprising local or international economic crises that limit the flow of infrastructure finance [8,52]. The financial crisis of 2007 to 2008 and the 2020–2023 COVID-19 outbreak had widespread effects on internal and external financial support for PPP investments in infrastructures [53]. During these periods of financial difficulty, the operation of projects came to a halt, affecting revenue targets negatively with additional costs from personal and protective gadgets and health and safety protocols. Akomea-Frimpong, Jin and Osei-Kyei [6] provide a guiding list of fifty-four (54) operation- and investment-related financial risks with a comprehensive review of studies. Revenue risks, lapses in contractual agreements on borrowing, high-interest costs that affect the repayment capacity of projects and soaring administrative expenditure for projects are listed as financial risks [54,55]. Studies emphasise the shortage of project finding with limited alternatives to a sustainable source of capital for projects in lower and middle-income economies. Xenidis and Angelides [56] and Zhang, Li, Li and Zhang [8] further mentioned the complexities of securing project finance for capital in developing nations because of poor loan credit and repayment ratings, which compound access to adequate financial packages. Emerging challenges of climate change and sustainability-backed issues have

called for additional mitigation measures in the management of the financial risks of PPP infrastructure [44]. However, extant literature is available on financial risk management; therefore, the relevance of this study is in developing sustainable infrastructure projects for PPP contracts.

3. Research Methodology

3.1. Survey Questionnaire Data

To extract financial risk mitigation measures (FRMMs) for sustainable public–private partnership infrastructure projects, a comprehensive literature review was conducted using scholarly depositories of publications including Scopus, ProQuest, Web of Science, ScienceDirect and Google Scholar. These scholarly and bibliographic sources are commonly used and popular in engineering and construction management research [57]. The keywords utilised in the search for literature in these databases were "financial risk controls", "mitigation strategies on financial risks", "financial control measures", "public-private partnerships", "sustainable public-private partnerships (PPPs)" and "PPP projects". The search showed 334 relevant research articles, projects and institutional reports, which were thoroughly analysed. A total of 32 key FRMM variables were extracted from the literature (see Table 2). To ascertain the relevance of the 32 FRMMs to Ghanaian PPP infrastructure projects, a pilot study was conducted with 12 PPP experts in Ghana: 5 academics and 7 industry practitioners. The experts confirmed that all of the FRMMs are important without any comments.

Following pilot testing, a questionnaire was drafted with two sections, namely, basic information about the participants (Section 1) and the financial risk mitigation measures on a 5-point Likert scale (Section 2). The questions asked in Section 1 were related to the educational background, work experience, project types, sectors and job titles of the respondents concerning PPP infrastructure projects in Ghana. The results are presented in Table 2. In the second part of the questionnaire (Section 2), participants in the survey were requested to respond to 32 FRMMs based on their agreement or disagreement with the statements (from strongly disagree to strongly agree). To distribute the questionnaire, PPP practitioners, academics and experts in Ghana for questionnaire responses served as the target population. A participant must be significantly participating in the activities of PPP infrastructure projects in Ghana for at least 5 years to take part in the data collection [58]. A thorough search of the social media profiles of PPP experts in Ghana revealed 78 potential participants who were contacted and accepted to be part of the data collection. The 78 potential participants invited 187 other experts who are knowledgeable and experienced in PPP infrastructure activities in Ghana using the snowballing sampling technique. The number of participants whose names, career positions and email contacts were gathered was 265. The survey questionnaire was keyed into Qualtrics software (Version 3.2.0), and the link generated was shared via emails with the participants. Responses were received from 251 participants out of 265 questionnaires emailed with 5 not fully filled in (less than 10% of responses to the statements in the questionnaire). The 5 responses were deleted with the remaining 246 responses retained for data analysis (see Table 1).

Table 1. Overview of questionnaire responses.

Characteristics	No. of Responses (n)	Percent (%)
Educational Qualification:		
Diploma	9	3.66
Undergraduate	158	64.23
Masters	63	25.61
PhD	16	6.50
Total	246	100.00
Work Experience:		
Years—6–10	143	58.13
Years—11–15	91	37.00

Table 1. *Cont.*

Characteristics	No. of Responses (n)	Percent (%)
Years—≥15	12	4.88
Total	246	100.00
Categories of responses:		
1. PPP sector		
Private	141	57.32
Public	105	42.68
Total	246	100.00
2. PPP project type		
Social	62	25.20
Economic	104	42.28
Environmental	80	32.52
Total	246	100.00
3. PPP practitioner (job title)		
Project manager	72	29.27
Quantity surveyor	56	22.76
Risk manager	67	27.24
Accountant	51	20.73
Total	246	100.00

3.2. Analytical Procedure for the Dataset

The entire data's reliability was tested using Cronbach's alpha (CA). The CA analysis showed a score of 0.865, a representation of the strong consistency and reliability between the variables within the questionnaire survey above the threshold of CA of 0.7 [54,59]. Following the reliability test, the normality test used was the Shapiro–Wilk test (SW). The test results of the SW indicated a non-normal distribution at p-values no greater than 0.05. The W statistic in the SW test showed a score of 0.938 ($p < 0.05$), further supporting the non-normal distribution of the dataset. According to King and Eckersley [60] and Razali and Wah [61], the W statistic represents the measurement of comparison between the order and the standardisation of the distribution of the dataset in relation to the normality curve. Due to the distribution-free nature (non-normal distribution) of the dataset, it was appropriate to further test the data with non-parametric statistical techniques. First, the Kendall's concordance W test (that is, Kendall's W coefficients) was conducted to assess the level of agreeability of the raters within each of the groups of the dataset: sector, project type and practitioners [62]. The Kendall's W coefficient was utilised when the attributable features were less or equal to seven (7). The greater the attributes (that is, more than seven (7)), the more suitable the chi-square approximation [63], hence the usage of the chi-square (critical values) with the degree of freedom in addition to the significance level. From Table 3, the chi-square is 44.985 (critical value) for the groups in rating the financial risk mitigation measures of PPP infrastructure projects. With these critical values being less than the computed chi-square values in Table 3, they affirm the genuineness, association and consistency of the agreement in the ratings of each of the groups [40,64]. Second, the critical differences of the respondents in the data groups were determined using the Mann–Whitney (MW) U test (sectors) and the Kruskal–Wallis (KW) test (project types and practitioners) together with the mean ranking (see Tables 4–6) [65]. The two statistical tools (MW U and KW tests) are quantitative non-parametric models [66]. Finally, the entire dataset was analysed using exploratory factor analysis (EFA). EFA is a factor reduction technique that can group several variables (or factors) that are correlated into different clusters. The following requirements must be met in conducting an effective EFA. The Cronbach's alpha, which has already been established to be more than 0.7, confirms the reliability of the dataset [67]. The Kaiser–Meyer–Olkin (KMO) test for the assessment of sufficient level of the data and the level of correlation (Bartlett's sphericity test) are the other fundamental conditions of EFA analysis with the results reported in Section 4.2 [68,69].

Table 2. Financial risk management measures for PPP infrastructure projects.

S/N	Financial Risk Mitigation Measures	Sources
FRMM1	Review PPP financial agreements from Ghana's Ministry of Finance	Chou and Pramudawardhani [70] and Akomea-Frimpong et al. [71]
FRMM2	Involve community leaders and stakeholders in financial risk management plans	Dansoh et al. [72] and Babatunde et al. [73]
FRMM3	Consult Ghanaian financial experts on PPP projects	Akomea-Frimpong et al. [74]
FRMM4	Long-term financial feasibility and sustainability evaluation of the project	Khahro et al. [75] and Du et al. [76]
FRMM5	Early detection of expenditure in fighting climate disasters in the project	Akomea-Frimpong, Agyekum, Amoakwa, Babon-Ayeng and Pariafsai [14] and Osei-Kyei et al. [77]
FRMM6	Spend within the project budget	Mazher et al. [78] and Castelblanco, Guevara and Salazar [53]
FRMM7	Apply sustainable financial instruments to reduce operating costs	Jiang et al. [79]
FRMM8	Review the influence of financial risks on environment and carbon emissions of the project	Mete et al. [80] and Akomea-Frimpong, Jin and Osei-Kyei [44]
FRMM9	Make use of financial data from international institutions and Ghana's parliament	Xu, Liu, Zhou and Lu [51] and Mazher, Chan, Choudhry, Zahoor, Edwards, Ghaithan, Mohammed and Aziz [78]
FRMM10	Embrace sustainable PPP financial contract management practices	Almarri and Boussabaine [81] and Akomea-Frimpong, Jin and Osei-Kyei [44]
FRMM11	Promote diversity and inclusion in financial management	Helmy et al. [82] and Osei-Kyei et al. [83]
FRMM12	Financial budgeting in the transition to sustainable projects	Kulshreshtha et al. [84] and Akomea-Frimpong, Jin and Osei-Kyei [44]
FRMM13	Lifecycle financial risk analysis of the sustainability of PPP projects	Wibowo and Alfen [85] and Jiang, Yang, Jiang, Martek and Gao [79]
FRMM14	Net-zero transition cost management skills	Mete, Hocquet, Sanchez, Talebian, Nilsson, Choi, Kyoung Lee, Lee and Moon [80] and Kamel et al. [86]
FRMM15	Implement net-zero procurement cost measures	Akomea-Frimpong, Agyekum, Amoakwa, Babon-Ayeng and Pariafsai [14] and El-Kholy and Akal [87]
FRMM16	Ensure high professionalism and competence of the project finance team	Jiang, Yang, Jiang, Martek and Gao [79] and Zhang, Li, Li and Zhang [8]
FRMM17	Apply sustainable value-for-money models	Ameyaw et al. [88] and Khahro, Ali, Hassan, Zainun, Javed and Memon [75]
FRMM18	Cost and benefit evaluation of the energy consumption of infrastructures	Kissi et al. [89] and Ohene et al. [90]
FRMM19	Leadership commitment to the financial sustainability of projects	Tan et al. [91]
FRMM20	Affordable user fees to attract more revenue	Akomea-Frimpong et al. [92]
FRMM21	Robust and transparent financial reporting systems	Castelblanco, Guevara and Salazar [53] and Akomea-Frimpong, Jin and Osei-Kyei [6]
FRMM22	Institutionalise audit controls and committees	Jiang, Yang, Jiang, Martek and Gao [79]
FRMM23	Equip project team with green and sustainable financial management skills	Osei-Kyei, Jin, Nnaji, Akomea-Frimpong and Wuni [77] and Xu, Liu, Zhou and Lu [51]
FRMM24	Constant updates in the financial risk response plan	Almarri and Boussabaine [81]
FRMM25	Minimum and sustainable revenue guarantee to private investors	Kavishe and Chileshe [93], Kuru and Artan [94]
FRMM26	Eradicate corruption and misuse of project funds	Ishawu et al. [95] and Akomea-Frimpong, Jin, Osei-Kyei and Pariafsai [74]
FRMM27	Sustainable renegotiation of financial contracts	Glumac, Han, Schaefer and van der Krabben [5]
FRMM28	Allow for a green participative budgetary process	Alnour et al. [96], Kamel, Khallaf and Nosaier [86]
FRMM29	A reasonable concession period for the recoupment of private investment	Xu, Liu, Zhou and Lu [51] and Sun et al. [97]
FRMM30	Sustainable budgetary funding from the government	Aladağ and Işik [4]
FRMM31	Inflation-linked operating revenue from the project	Babatunde, Perera, Zhou and Udeaja [73] and Angelides and Xenidis [33]
FRMM32	Borrow green finance at the lowest interest charges	Akomea-Frimpong et al. [98]

Table 3. Summary of the Kendall's concordance test.

Characteristics	Sector		Practitioners				Project Type		
	Private	Public	Project Managers	Quantity Surveyors	Risk Managers	Accountant	Social	Economic	Environmental
Participants in the survey (N)	141	105	72	56	67	51	62	104	80
Kendall's W test	0.326	0.416	0.258	0.347	0.289	0.403	0.371	0.297	0.342
Chi-square (X^2)	843.123	712.451	451.367	335.124	412.567	264.147	378.478	703.641	478.437
Critical value of X^2	44.985	44.985	44.985	44.985	44.985	44.985	44.985	44.985	44.985
Degrees of freedom	31	31	31	31	31	31	31	31	31
Asymptotic significance	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 4. Key financial risk mitigation measures based on the data of the PPP sectors.

	PPP Sectors						Mann–Whitney U Test		
	Public Sector			Private Sector					
S/N	MS	SD	Rank	MS	SD	Rank	U-Stat	*p*-Value	Sign./Decision
FRMM2	4.83	0.64	2	3.87	1.24	17	12.528	0	S, RNH
FRMM22	4.71	0.65	3	3.13	1.27	23	10.617	0	S, RNH
FRMM31	4.69	0.5	4	3.03	1.25	25	5.554	0	S, RNH
FRMM20	4.10	0.64	10	4.82	1.29	4	7.662	0	S, RNH
FRMM25	4.37	0.65	5	4.78	1.33	5	21.755	0	S, RNH
FRMM15	4.34	0.61	6	4.73	1.37	6	15.865	0	S, RNH
FRMM6	4.25	0.62	7	4.63	1.43	7	22.047	0	S, RNH
FRMM8	4.19	0.66	8	4.58	1.35	8	8.808	0	S, RNH
FRMM19	4.12	0.62	9	4.47	1.41	9	14.982	0	S, RNH
FRMM1	4.09	0.63	11	4.34	1.38	10	11.908	0	S, RNH
FRMM3	4.05	0.62	12	4.24	1.44	11	2.061	0	S, RNH
FRMM14	4.85	0.61	1	4.15	1.47	12	4.153	0	S, RNH
FRMM26	2.97	0.62	24	4.08	1.36	13	11.845	0	S, RNH
FRMM17	3.87	0.74	13	4.02	1.47	14	8.153	0	S, RNH
FRMM21	3.85	0.73	14	3.95	1.44	15	2.086	0	S, RNH
FRMM28	3.74	0.59	15	3.91	1.39	16	7.927	0	S, RNH
FRMM5	3.67	0.65	16	4.91	1.45	2	2.092	0	S, RNH
FRMM11	3.44	0.64	17	3.85	1.43	18	11.031	0	S, RNH
FRMM24	3.38	0.82	18	3.79	1.42	19	0.007	0	S, RNH
FRMM18	3.32	0.65	19	3.43	1.4	20	11.96	0	S, RNH

Table 4. *Cont.*

	PPP Sectors						Mann–Whitney U Test		
	Public Sector			Private Sector					
S/N	**MS**	**SD**	**Rank**	**MS**	**SD**	**Rank**	**U-Stat**	***p*-Value**	**Sign./Decision**
FRMM10	3.24	0.73	20	3.37	1.46	21	4.14	0	S, RNH
FRMM32	3.16	0.84	21	3.23	1.44	22	2.073	0	S, RNH
FRMM7	3.13	0.96	22	4.92	1.37	1	19.87	0	S, RNH
FRMM9	3.02	0.88	23	2.65	1.42	29	2.019	0	S, RNH
FRMM30	2.94	0.98	25	4.88	1.4	3	11.957	0	S, RNH
FRMM16	2.83	0.9	26	2.84	1.38	32	1.977	0	S, RNH
FRMM27	2.74	0.97	27	2.82	1.48	31	20.044	0	S, RNH
FRMM4	2.69	0.88	28	2.73	1.39	30	5.163	0	S, RNH
FRMM13	2.65	1.05	29	2.94	1.44	24	2.086	0	S, RNH
FRMM29	2.61	0.93	30	2.62	1.47	28	11.927	0	S, RNH
FRMM12	2.57	0.45	31	2.59	1.43	27	13.202	0	S, RNH
FRMM23	2.53	0.93	32	2.54	1.41	26	15.91	0	S, RNH

Table 5. Perspectives of PPP practitioners concerning financial risk mitigation measures.

	Perspectives of PPP Practitioners												Kruskal–Wallis Test		
	Project Managers			Quantity Surveyors			Risk Managers			Accountants			H-Stat.	*p*-Value	Sig./Decision
FRMM	**MS**	**SD**	**Rank**	**MS**	**SD**	**Rank**	**MS**	**SD**	**Rank**	**MS**	**SD**	**Rank**			
FRMM1	4.83	1.47	1	3.03	1.25	28	2.59	1.08	32	2.84	0.40	31	5.69	0.00	S, RNH
FRMM3	4.62	1.38	2	2.68	1.11	31	3.65	1.21	19	2.73	0.30	32	45.03	0.00	S, RNH
FRMM4	4.59	1.37	3	3.4	1.08	25	3.13	1.19	26	2.91	0.41	30	12.52	0.00	S, RNH
FRMM6	4.53	1.42	4	4.72	1.07	5	3.54	1.01	21	3.02	0.49	29	16.72	0.00	S, RNH
FRMM7	4.43	1.41	5	4.67	1.22	6	4.31	1.18	11	3.05	0.29	28	13.62	0.00	S, RNH
FRMM2	4.38	1.44	6	4.62	1.25	7	3.81	1.24	17	3.11	0.37	27	1.74	0.27	INS, AAH
FRMM8	4.29	1.38	7	4.57	0.89	8	3.39	1.16	23	3.17	0.64	26	51.31	0.00	S, RNH
FRMM5	4.18	1.45	8	2.72	1.30	9	3.21	1.29	25	3.21	0.35	25	11.62	0.00	S, RNH
FRMM11	4.09	1.45	9	4.41	1.37	10	4.02	1.19	15	3.27	0.24	24	7.75	0.00	S, RNH
FRMM32	4.03	1.43	10	4.37	1.36	11	2.85	1.15	29	3.36	0.08	23	5.31	0.00	S, RNH
FRMM14	3.99	1.44	11	4.31	1.32	12	4.47	1.18	5	3.44	0.29	22	7.94	0.00	S, RNH
FRMM23	3.76	1.40	12	4.28	1.24	13	3.97	1.34	16	3.49	0.16	21	6.81	0.00	S, RNH
FRMM16	3.56	1.38	13	4.24	1.16	14	3.61	1.23	20	3.53	0.20	20	11.63	0.00	S, RNH

Table 5. *Cont.*

	Perspectives of PPP Practitioners												Kruskal–Wallis Test		
	Project Managers			Quantity Surveyors			Risk Managers			Accountants			H-Stat.	*p*-Value	Sig./Decision
FRMM	**MS**	**SD**	**Rank**	**MS**	**SD**	**Rank**	**MS**	**SD**	**Rank**	**MS**	**SD**	**Rank**			
FRMM15	3.49	1.34	14	4.17	1.17	15	2.72	1.05	30	3.57	0.17	19	11.42	0.00	S, RNH
FRMM21	3.38	1.43	15	4.13	1.26	16	3.52	1.23	22	3.64	0.29	18	31.43	0.00	S, RNH
FRMM30	3.32	1.42	16	4.05	1.29	17	4.29	1.21	12	3.71	0.11	17	12.41	0.00	S, RNH
FRMM9	3.21	1.42	17	3.94	1.26	18	4.45	1.19	6	3.76	0.20	16	8.52	0.00	S, RNH
FRMM17	3.17	1.39	18	3.85	1.21	19	3.28	1.24	24	3.83	0.30	15	16.30	0.00	S, RNH
FRMM28	3.13	1.43	19	3.81	1.30	20	4.56	1.33	2	3.87	0.11	14	27.30	0.00	S, RNH
FRMM10	3.07	1.44	20	3.72	1.31	21	4.24	1.25	13	3.92	0.17	13	28.80	0.00	S, RNH
FRMM18	3.04	1.38	21	3.67	1.20	22	4.49	1.15	4	4.10	0.33	12	38.90	0.00	S, RNH
FRMM26	2.95	1.40	22	4.89	1.27	2	4.39	1.33	15	4.14	0.05	11	14.90	0.00	S, RNH
FRMM19	2.91	1.41	23	3.49	1.20	24	2.87	1.20	28	4.19	0.35	10	7.12	0.00	S, RNH
FRMM27	2.86	1.42	24	4.78	1.25	3	3.74	1.26	18	4.25	0.20	9	6.62	0.00	S, RNH
FRMM22	2.82	1.43	25	3.25	1.26	26	4.41	1.31	8	4.32	0.23	8	39.12	0.00	S, RNH
FRMM20	2.79	1.41	26	3.19	1.25	27	4.53	1.18	3	4.37	0.27	7	9.40	0.00	S, RNH
FRMM12	2.75	1.41	27	4.96	1.22	1	2.63	1.16	31	4.47	0.31	6	9.25	0.00	S, RNH
FRMM31	2.69	1.45	28	2.63	1.35	32	4.42	1.35	7	4.85	0.12	1	0.10	0.89	INS, AAH
FRMM13	2.66	1.46	29	2.77	1.34	30	4.34	1.23	10	4.59	0.20	4	7.09	0.00	S, RNH
FRMM24	2.61	1.39	30	4.48	1.23	4	4.11	1.36	14	4.72	0.25	3	19.80	0.00	S, RNH
FRMM29	2.59	1.36	31	3.55	1.18	23	3.09	1.32	27	4.77	0.09	2	99.00	0.00	S, RNH
FRMM25	2.54	1.37	32	2.89	1.15	29	4.62	1.31	1	4.53	0.26	5	10.03	0.00	S, RNH

Table 6. Analysis of project PPP types on financial risk management measures.

	PPP Infrastructure Project Types									Kruskal–Wallis Test		
	Economic Projects			Social Projects			Environmental Projects			H-Stat	*p*-Value	Sign./Decision
FRMM	**MS**	**SD**	**Rank**	**MS**	**SD**	**Rank**	**MS**	**SD**	**Rank**			
FRMM11	4.85	1.07	1	4.10	1.63	14	3.15	0.07	32	6.19	0.00	S, RNH
FRMM9	4.81	0.74	2	2.75	1.71	30	3.19	0.72	31	31.20	0.00	S, RNH
FRMM15	4.78	0.72	3	4.73	1.85	2	3.28	0.79	30	7.11	0.00	S, RNH
FRMM8	4.73	0.78	4	4.69	1.76	3	3.32	0.61	29	14.90	0.00	S, RNH
FRMM17	4.69	0.72	5	4.63	1.62	4	3.41	0.64	28	11.12	0.00	S, RNH
FRMM6	4.58	0.43	6	4.55	1.85	5	3.49	1.06	27	19.31	0.00	S, RNH
FRMM21	4.42	0.40	7	4.49	2.08	6	3.55	1.22	26	15.92	0.00	S, RNH
FRMM2	4.41	0.31	8	4.43	2.18	7	3.65	1.31	25	5.57	0.00	S, RNH
FRMM10	4.38	0.35	9	4.37	1.91	8	3.71	1.20	24	13.72	0.00	S, RNH
FRMM1	4.34	0.29	10	4.33	2.16	9	3.75	1.30	23	12.54	0.00	S, RNH
FRMM13	4.32	0.23	11	4.28	1.91	10	3.79	1.14	22	11.19	0.00	S, RNH
FRMM7	4.26	0.06	12	4.25	1.95	11	3.82	1.25	21	26.13	0.00	S, RNH
FRMM16	4.22	0.13	13	4.21	1.84	12	3.82	1.15	20	0.21	0.84	INS, AAH
FRMM4	4.16	0.11	14	4.19	1.78	13	3.83	1.18	19	26.82	0.00	S, RNH
FRMM14	4.08	0.20	15	2.71	2.07	32	4.04	1.31	18	17.83	0.00	S, RNH
FRMM18	4.03	0.15	16	4.08	1.90	15	4.26	1.24	17	43.12	0.00	S, RNH
FRMM27	3.92	0.23	17	4.03	2.03	16	4.31	1.27	16	0.04	1.05	S, RNH
FRMM32	3.81	0.01	18	3.97	2.02	17	4.43	1.30	15	5.59	0.00	S, RNH
FRMM19	3.74	0.09	19	3.91	2.04	18	4.49	1.31	14	12.13	0.00	S, RNH
FRMM26	3.72	0.18	20	3.88	1.88	19	4.51	1.22	13	9.91	0.00	S, RNH
FRMM31	3.69	0.02	21	3.70	1.73	20	4.51	1.10	12	13.14	0.00	S, RNH
FRMM23	3.62	0.17	22	3.62	1.82	21	4.54	1.16	11	10.29	0.00	S, RNH
FRMM29	3.56	0.02	23	3.55	1.79	22	4.57	1.20	10	20.32	0.00	S, RNH
FRMM5	3.53	0.10	24	3.43	2.06	23	4.58	1.31	9	11.11	0.00	S, RNH
FRMM30	3.49	0.07	25	3.38	2.08	24	4.60	1.35	8	16.91	0.00	S, RNH
FRMM3	3.47	0.00	26	3.27	1.83	25	4.61	1.23	7	31.29	0.00	S, RNH
FRMM22	3.41	0.15	27	3.15	1.70	26	4.71	1.07	6	18.10	0.00	S, RNH
FRMM20	3.22	0.01	28	3.06	1.91	27	4.82	1.27	5	13.32	0.00	S, RNH
FRMM28	3.15	0.09	29	2.93	1.95	28	4.86	1.24	4	12.39	0.00	S, RNH
FRMM25	3.02	0.12	30	2.73	1.75	31	4.87	1.15	3	9.11	0.00	S, RNH
FRMM12	2.95	0.00	31	2.83	0.45	29	4.91	0.00	2	12.131	0.00	S, RNH
FRMM24	2.61	0.00	32	4.76	1.34	1	4.95	0.00	1	7.5421	0.00	S, RNH

4. Results and Discussions

4.1. Criticality Assessment of Financial Risk Mitigation Measures

The results of the critical assessment of measures of financial risk in PPP infrastructure development are presented in this section. Three categories of criticality assessment are undertaken in this section in reference to the key PPP sectors, practitioners and forms of projects. The criticality assessment was taken to justify the inclusion or inclusion of the 32 FRMM variables (refer to Table 1) for factor analysis (Section 4.2). Using the means (MS) of the data, the criticality threshold was benchmarked at 50% (2.5) or more of the five ranks on the Likert Scale ($\geq$2.5). The MS of 2.5 or greater was utilised in ranking variables in construction, PPP and engineering management literature such as publications by Nguyen, Nguyen, Doan and Dang [55], Zhang [99] and Cheung and Chan [100]. From Tables 4–6, the MS demonstrates that all of the FRMMs attained more than 2.5 mean scores, indicating their relevance in the subsequent analysis. Furthermore, the key sectoral differences in the management strategies of financial risk were analysed using the Mann–Whitney U test (significant at 0.05). The null hypothesis set explains that there are no differences in the approach to managing financial risk in the two sectors while the alternative hypothesis states otherwise [101]. The findings in Table 4 show the significance (S) of the analysis for all FRMM variables (p-value < 0.05) between the two sectors of the FRMMs, hence the rejection of the null hypothesis (RNH). This means that the two sectors hold different views and possibly use different strategies in mitigating adverse financial outcomes from projects. In Tables 5 and 6, PPP practitioners and project types are assessed in response to the mitigation strategies for PPP financial risks. The hypothesis of the Kruskal–Wallis test was no disagreements among practitioners and the type of project on the FRMMs [102,103]. Except for FRMM2, FRMM12 (Table 5) and FRMM16 (Table 6), where the null hypothesis was accepted (ANH), all the FRMM variables produced significance values less than 0.05. With these results, the rejection of the null hypothesis (RNH) ensued, which is explained by the practitioners and project types having different measures in minimising financing and operating losses. In the case of FRMM2, respondents hold the same view that it is important to get involved with traditional and community leaders in the design and implementation of financial measures to foster PPP infrastructure success. In FRMM12 and FRMM16, respondents also hold a common view that it is important that project team members are equipped with innovative skills in budgeting and financial management in transitioning to sustainable PPP infrastructure management across the country (Ghana).

4.2. Factor Analysis

To extract the principal groups of the financial risk mitigation measures together with the assessment of the underlying relationships that exist between FRMMs, an exploratory factor analysis (EFA) was conducted. Fabrigar et al. [104] and Howard [105] mentioned that EFA is a preferable technique to discover and assess the nature of the structure of the factors underlying a dataset when no prior hypotheses of the dataset have been established. Before the EFA, the following conditions were met [106,107]. First, the internal consistency reliability test produced a Cronbach's alpha score of 0.865 which is above the standard threshold, $\geq$0.7 score [7]. Secondly, the correlation matrix scores exhibiting the interrelationships of the FRMMs were established at $\geq$0.3 (at the significance level of 5%, p-values < 0.05) [108]. Third, the Kaiser–Meyer–Olkin (KMO) test together with Bartlett's test of sphericity (BTS) ensued with scores showing 0.887 for the KMO test and 7757.43 for BTS (approximation chi-square) recorded at the significance of 0.0000 (5% significance level). The results show the sample's adequacy, the fitness of the model and sustainability for factor analysis together with disproving the identified correlation matrix of the datasets [109]. The stage was then set for factor analysis with the extraction method set as principal component analysis (PCA) using the varimax orthogonal rotation option at a Kaiser normalisation convergence from seven iterations [110]. PCA was selected for the extraction of the factors due to its superior dimension reduction and uncorrelated features which keep maximum information and variances of the dataset in the process of extracting principal groups [111,112]. Compared

to other rotation methods in EFA analysis, the varimax rotation method is orthogonal in nature, which optimises the variances within the data distribution with greater correlation between the principal groups and the sub-component variables [68]. The outcome of the EFA produced six principal components with more than 1.0 of the eigenvalues and cumulative variance explained as 71.011% (see Table 7). In the process of checking the factor loadings, it was discovered that three of the FRMMs produced factor loadings below 0.7; therefore, they were removed [113]. These include FRMM (0.043), FRMM8 (0.174) and FRMM19 (0.142). The remaining twenty-nine FRMMs with factor loadings more than 0.7 are shown in Table 7 [114]. Lastly, the multicollinearity among the factors related to the principal component analysis was checked, and the clear boundary that was set was that any correlation coefficient among the variables with 0.5 or above was considered multicollinear. From the analysis, all of the correlation coefficients were below 0.5, indicating no multicollinearity within the factors of the principal components [115,116].

4.3. Discussion of the Results

The results from the assessment of the data in the previous section can be interpreted as follows.

Component 1: Resilient budgets and financial plans

This group of FRMMs constitutes 24.192% of the variance explained of the measures in ensuring the financial success of PPP infrastructure projects in Ghana. The starting point to realising resilient financial risk management is to design budgets and financial plans [117]. This includes the development of rigorous budgetary and financial policies at the national level either from the Parliament of Ghana or ministerial budgets to direct builders and operators of the existing thirty (30) PPP infrastructures [19]. Without a detailed financial risk management plan before the financial closure stage, there could be a soaring of financial risks because there are plans to identify and manage project cost hotspots and limited revenues. At the firm and project levels, a participatory approach towards budgeting and financial planning within project teams is recommended to embrace expert and consulting advice on project budgets from academics and institutions that support PPP projects. Academic professionals from Ghana's topmost educational institutions such as Kwame Nkrumah University of Science and Technology (College of Arts and Building Environment) and the University of Ghana (School of Engineering Sciences) can be helpful in designing financial budgets for projects. Furthermore, institutions and groups like the Ghana Institute of Engineers, KPMG and Project Management Institute (PMI) Ghana as well as governmental and private firms must be part of developing financial plans for PPP infrastructures. An inclusive budgeting process should allow for the perspectives of traditional and community leaders to be part of budgeting decisions and financial transactions. Traditional land rights and customs must be respected and recognised in the process of drawing up strategic long-term budgets for projects. Ghana is a culturally diverse country with different tribes and land ownership titles, so it is important that families and traditional owners are compensated and catered for in the future financial plans of projects [52]. Also, a careful strategy to achieve financial resilience should be designed to meet unexpected hikes in project costs and revenue shortfalls [118]. Responsive financial strategies and constant budget updates should be activated in the face of the financial turmoil the country Ghana has been facing in the last few years [119]. Financial plans to transform existing and under-construction PPP projects in Ghana into low-carbon, climate-resilient and possibly net-zero projects should be drafted with the support of the Ministry of Finance, international donor partners and project teams [5].

Table 7. Components, factor loadings, eigenvalues and variance explained from the factor analysis.

S/N	Financial Risk Mitigation Measure (FRMM)	Components/Factor Loadings					
		1	**2**	**3**	**4**	**5**	**6**
Component 1	Resilient budgets and financial plans						
FRMM2	Involve community leaders and stakeholders in financial risk management plans	0.914					
FRMM3	Consult Ghanaian financial experts on PPP projects	0.901					
FRMM6	Spend within the project budget	0.871					
FRMM12	Financial budgeting in the transition to sustainable projects	0.856					
FRMM24	Constant updates in the financial risk response plan	0.825					
FRMM28	Allow for a green participative budgetary process	0.781					
FRMM30	Sustainable budgetary funding from the government	0.763					
Component 2	Ensure inclusive cost controls						
FRMM5	Early detection of expenditure in fighting climate disasters in the project		0.883				
FRMM7	Apply sustainable financial instruments to reduce operating costs		0.852				
FRMM10	Embrace sustainable PPP financial contract management practices		0.844				
FRMM11	Promote diversity and inclusion in financial management		0.813				
FRMM15	Implement net-zero procurement cost measures		0.776				
FRMM22	Institutionalise audit controls and committees		0.723				
Component 3	Apply sustainable funding strategies						
FRMM1	Review PPP financial agreements from Ghana's Ministry of Finance			0.896			
FRMM9	Make use of financial data from international institutions and Ghana's parliament			0.853			
FRMM26	Eradicate corruption and misuse of project funds			0.826			
FRMM27	Sustainable renegotiation of financial contracts			0.782			
FRMM29	A reasonable concession period for the recoupment of private investment			0.768			
FRMM32	Borrow green finance at the lowest interest charges			0.715			
Component 4	Practise revenue-boosting measures						
FRMM17	Apply sustainable value-for-money models				0.864		
FRMM20	Affordable user fees to attract more revenue				0.831		
FRMM25	Minimum and sustainable revenue guarantee to private investors				0.806		
FRMM31	Inflation-linked operating revenue from the project				0.767		

Table 7. *Cont.*

S/N	Financial Risk Mitigation Measure (FRMM)	Components/Factor Loadings					
		1	**2**	**3**	**4**	**5**	**6**
Component 5	Promote innovative skills and competencies						
FRMM14	Net-zero transition cost management skills					0.897	
FRMM16	Ensure high professionalism and competence of the project finance team					0.885	
FRMM23	Equip the project team with green and sustainable financial management skills					0.747	
Component 6	Build green financial risk analysis models						
FRMM13	Lifecycle financial risk analysis on the sustainability of PPP projects						0.828
FRMM18	Cost and benefit evaluation of the energy consumption of the infrastructures						0.756
FRMM21	Robust and transparent financial risk reporting systems						0.729
	Eigenvalues	5.419	3.764	3.105	2.845	1.793	1.041
	Variance explained (%)	24.192	18.135	12.114	8.721	4.928	2.921
	Cumulative variance explained (%)	24.192	42.327	54.441	63.162	68.09	71.011

Component 2: Ensure inclusive cost controls.

Component 2 accounts for 18.135% of the variation in the dataset in explaining the effects of inclusive cost control measures for successful PPP infrastructure delivery in Ghana. Implementation of an inclusive cost management framework should be a prime goal of project managers with multidisciplinary and multidimensional approaches to gather enough cost information and allow all project participants to be part of financial risk management [120]. This starts with having a project cost budget put together competent staff such as a cost estimator, a quantity surveyor and an accountant who know a lot about the Ghanaian economy, the key expenses of projects and the implications of each expenditure. For instance, the exemplary leadership and competency of financial advisors in cost controls were instrumental in executing the Tema Motorway Interchange project, estimated at AUD 60 million [121]. A realistic cost plan for the effect of climate-related disasters on a project should be developed early and implemented throughout the lifecycle. This cost plan should be inclusive of maintenance fees and relief payments to affected stakeholders and communities. Also, a comprehensive organisational approach to reporting costs to various stakeholders together with integrated cost controls on financial risks should be enhanced in the wake of technological advancements. To frame comprehensive working cost management, previous reports on the expenditure of similar projects can be analysed and utilised to develop new cost budgets [122,123]. The reliance on previous cost reports should receive wide acceptance and recognition from key stakeholders towards improving the success of the project with the introduction of project audit committees and cost trackers. Cost management strategies such as option, swap and forward contracts are useful in minimising excessive project costs in a developing economy like Ghana where the cost of living crisis has impacted negatively on the prices of construction, labour and materials. Sustainable financial instruments such as green bonds and equity should be solicited to finance projects [124]. Excessive project costs also arise from rising operation and maintenance costs emboldened by increasing inflation and exchange rate risks. [4]. Effective cost strategies should also promote practices that reduce environmental challenges towards net-zero infrastructures and sustainable profitability for financiers [125].

Component 3: Apply sustainable funding strategies.

This principal component explains 12.114% of the variance in the dataset. Sustainable and green finance is the future of Ghana's infrastructural development [126]. Chen et al. [127] and de Marco et al. [128] mentioned that sustainable debt (loan) funds allocated to assist PPPs should cover a lengthy period with the capacity to manage the revenue risks of PPP projects. Sustainable funding approaches ensure the interest fees on contracted loans to build a project are predicated on the loan agreement's terms and conditions [129]. Even though it has been noted that the borrowing rates of infrastructure funds in Ghana are high, sustainable finance products such as green loans are granted on lower interest charges [124]. Recent events such as the COVID-19 pandemic and the economic crisis have worsened Ghana's economic position in attracting funds from local and international lenders [130,131]. The outcomes of the crisis have increased the interest rate to 27–35% on borrowings to support infrastructural projects [132]. To manage this risk, PPP project managers should agree on favourable and sustainable contractual terms on principal loans, loan loss, high debt, conflicting problems between the interests of creditors and debtors, repayments and the timeframe to repay loans. The increment in the financial investments of PPP infrastructures can be augmented through the extension of concession periods for projects. Concession periods influence hedging and the management of revenue mobilisation through long-term income generation packages. In addition, the financing risks associated with PPP capital can be disbursed through sustainable equity funds, retirement funds and insurance coverage when the agreed time is declared for the project [117,133]. As an open and mixed economy, the private sector and the national government have access to different funding instruments within a reasonable concession period in Ghana for repayment and debt restructuring [134]. Cudjoe et al. [135] and Kukah et al. [136] articu-

lated that the application for funding in renewable energy infrastructure projects in Ghana has gained popularity as the country explores different measures to end its intermittent electricity crisis [50].

Component 4: Practise revenue-boosting measures

Component 4 comprises measures to improve the revenue mobilisation of PPP infrastructures in Ghana at 8.721% of the variance explained. Sun, Jia and Wang [97] mentioned that to attract financial capital and increase the revenue of projects, a minimum revenue guarantee could be agreed upon at the onset of a project. This means that the public institutions in Ghana together with the national government should be obliged to allow private financiers to enjoy a minimum amount of cash flow to offset their expenses [137]. User-oriented prices should be designed to attract more people to utilise the infrastructure facilities built within the PPP arrangements. One suggestion is to build a positive brand for PPP infrastructures through the provision of quality and affordable prices. This could attract more Ghanaians to patronise the PPP infrastructures. Generally, user reviews on public facility management in the country are poor, preventing people from using public projects [101]. In Ghana, public facilities are hardly maintained, repaired, or repainted, leading to low interest in their usage [138]. To increase revenues, these problems should be resolved by improving quality standards and offering regular maintenance of facilities. A common unethical practice among public servants is to either steal or channel incomes from projects into their personal accounts. Project teams should institute effective revenue tracking systems to avoid this anomaly together with measures to minimise operating expenses.

Component 5: Promote innovative skills and competencies.

Component 5 reflects 4.928% of the explanation of the variance in the spread in the dataset. Innovative financial skill acquisition and competency development among project teams are important in achieving sustainable and net-zero PPP infrastructures in Ghana [139]. In this regard, financial education in the form of soft or hard skills is required to make significant changes in the current models of investments in infrastructure projects [140]. Skills in environmental assessment, net-zero and social impacts together with the financial position of the project should influence creativity, with alternative and renewable financial solutions towards sustainable PPP infrastructures [141]. Already, the understanding of new investments in PPP projects among project teams is well documented, but it is the competencies and technical know-how on the transition to sustainable net-zero project management that are lacking in the PPP sector. Offering these innovative skills will be valuable with traditional cost management skills in terms of time, cost and quality [142].

Component 6: Build green financial risk analysis models

The variance explained by this group of FRMM is 2.921% of the exploratory factor analysis. This group emphasises building and using a sustainable financial risk analysis approach to PPP infrastructures within Ghana. It entails listing international, local and cross-industry scenarios to measure and mitigate financial losses with cost and benefit analysis [143,144]. PPP project management firms and teams should design robust financial risk identification and mitigation scores to guide the improvement of financial outcomes. Financial risk tools such as fuzzy techniques, objective benchmarking, key performance indicators, FMEA (failure, modes and effects analysis) and probability/impact ranking approaches should embrace social–cultural and environmental factors within the Ghanaian PPP project setting [145]. Green financial risk models are essential in feasibility studies in project forecasting measures to deal with macroeconomic risks. In this information age of newer technologies, PPP infrastructure projects accentuate the need to address data and information on raw materials, health and safety, labour and the subcontracting of projects together with transparent reporting systems [146]. Financial information on climate change, the circular economy, wearable safety gadgets and diversity policies was sourced from

the Ghana database section on the World Bank, International Monetary Fund (IMF) and Ministry of Finance, Ghana websites to aid budget forecasting and project schedules [5,147].

5. Implications of the Study

This study is relevant to practitioners of PPP project management within Ghana and similar developing nations in the process of updating existing project policies and designing new policies and frameworks towards mitigating financial risks. The results could aid the development of sustainable models on financial risks to improve profitability and attract investment. Moreover, at the firm level, strategic changes could happen with the framing of internal controls on responsibilities towards the minimisation of financial risk. At the project level, the complexities and confusion that are associated with financial management could be resolved with multidimensional budgets for project management knowledge areas. Project teams involved in PPP infrastructure projects should be guided to develop lifecycle-based financial models to countermeasure the financial challenges of PPP infrastructure development. To investors (private sector) who are interested in Ghana's PPP infrastructure projects, this article offers insights into the key financial risks that are likely to hamper the maximisation of their investment. This study will provide potential investors with an understanding of the above and guidance on the key financial risk factors influencing PPP investments. Accordingly, investors can take precautionary measures to tackle these risks and improve upon the outcomes of their financial investments. Investors will know the roles they will play in mitigating financial risks. Future research works will benefit from this article on who to consult to gain data and the critical areas that need further investigation concerning financial management in PPP infrastructure development in Ghana.

6. Conclusions

In this study, financial risk mitigation measures towards sustainable PPP infrastructure projects in Ghana were analysed using 32 variables extracted from the existing literature, including project reports and institutional reports. Through a questionnaire survey, experts and practitioners on PPP infrastructure responded to the 32 FRMMs. The results revealed financial risk management measures from feasibility studies on the financial viability of projects, the use of sustainable financial risk assessment models and a call for the involvement of community leaders and users to be part of financial risk management plans. This study has also revealed that project teams should apply inclusive cost reduction strategies, advocate for sustainable funding of projects and equip team members to have sustainable and net-zero-based financial management skills. Additionally, the public sector must provide facilitation support in supervising PPP projects, therefore reducing the project's operational expenses. The public sector supervises the financial management of PPP projects to ensure that the project team complies with Ghana's financial regulations. Also, the public sector reviews the progress reports of projects to detect and prosecute individuals involved in financial mismanagement scandals. Debt and risk hedging strategies should be permitted or altered at the discretion of PPP implementation and supervisory committees to cater to unexpected financial risks. The financial risk management measures covered some of the emerging sustainability issues during the pre-construction, construction and post-construction stages of PPP infrastructure projects. From this study, the following limitations must be addressed in future studies. Key stakeholders such as users of PPP infrastructures and community leaders were not involved in the data collection process. Additionally, the sample of data utilised in this study is from practitioners on the existing 30 mega and national infrastructure projects within the PPP arrangements, with almost all of the projects concentrated in Accra and Kumasi, the two metropolitan cities in Ghana. Practitioners in other major regional areas and local councils were not part of this study due to time and financial resource constraints. Future studies should include these stakeholders in an extended data collection timeframe. Furthermore, it is recommended that stakeholders from the public sector, particularly the Ministry of Finance, and the Bank of Ghana stabilise

the cedi through effective fiscal and monetary policies. The stabilisation of the Ghanaian currency will increase the confidence of local and foreign investors in PPP projects in the country. Future studies should explore measures to overcome these data collection challenges and increase the sample size to gain a holistic insight into managing the budget and financing losses of projects. Emerging issues that impact the financial management of projects such as diversity and inclusion, climate change, the circular economy and the transition to smart technologies in construction have not been thoroughly addressed in PPP infrastructure in Ghana. Furthermore, different PPP projects have peculiar challenges in achieving economic sustainability, health and safety for construction workers and social benefits to the community; therefore, further research should be conducted involving project-specific studies.

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