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Evaluating the Impact of Public-Private Partnerships on Toll Road Infrastructure in Jammu and Kashmir

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ABSTRACT

Public-Private Partnerships (PPPs) have emerged as a transformative model for infrastructure development, particularly in regions with constrained public resources and logistical challenges. This study evaluates the impact of PPP initiatives on toll road infrastructure in the union territory of Jammu and Kashmir (J&K), a region marked by geopolitical sensitivity and a growing need for reliable transport connectivity. Drawing upon a sample of 150 respondents, including toll road users and key stakeholders, the research employs a quantitative methodology using structured questionnaires and advanced statistical tools such as Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM). It examines six intrinsic constructs, namely, PPP Effectiveness, Road Quality, Travel Convenience, Toll Affordability, Institutional Support, and User Satisfaction. The descriptive statistics indicate that there is a great perception among the people on the success of PPPs in regard to improvement of the quality and connectivity of roads, but still, the people are worried about the affordability of the tolls. SEM findings assert that the PPP effectiveness has significant and positive correlations with satisfactory road infrastructure outcomes, where institutional support also acted as an important promoter of user satisfaction. The conceptual model has a 64 percent explainable variance on user satisfaction, emphasizing the strength of the conceptual model. Results point out that PPPs can be used in a critical role in improving infrastructure delivery in a hazardous environment, so long as the problem of cost equity and institutional governance is considered. Theoretically, the study proves an argument that is highly user-cantered in their assessment of PPPs and provides some practical lessons to policymakers, managers of infrastructure, and development agencies with the intention of establishing PPPs in a region such as such as complex as this. Future research possibilities and limitations are also mentioned to direct future academic research.

Keywords: Public-Private Partnerships, Toll Road, User Satisfaction, Development of Infrastructure, Jammu and Kashmir, Structural Equation Modeling

INTRODUCTION

The creation of infrastructure is a key determinant of economic growth, regional connectivity and social integrity. Among various infrastructure components, road transport remains the backbone of a nation's logistics and mobility framework. Nevertheless, sometimes due to its resource-demanding character, especially when it is developed in geographically and politically sensitive areas, road development may demand innovative financing and implementation modes. One such approach that has gained global prominence over the past few decades is the Public-Private Partnership (PPP) model. Public-Private Partnerships is a form of agreement between the government and private organizations, which share tasks, risks and gains in providing the programs of infrastructure. The PPPs are widely used in road transport in the construction of the toll roads and the operation and maintenance of these roads, where investors provide finances and expertise to build the toll roads and get compensated in user fee and government incentive. The concept aims at utilizing the efficiency of the market sector towards the greater good of the people.

India has significantly become the most ambitious nation that has taken PPPs in the construction of infrastructure and mostly the road sector. With the ambitious National Highways Development Project (NHDP), the Bharatmala Pariyojana, and the increasing push toward privatization under the National Infrastructure Pipeline (NIP), PPPs have become central to India’s strategy to upgrade its transportation network. The initiatives are focused on not only increasing the geographic extent of such road coverages but also increasing the quality, decreasing traffic density and improving the experience of the users. Within this broader national framework, Jammu and Kashmir (J&K) presents a compelling case for examining the efficacy of PPPs in road infrastructure. The Union Territory (formerly a state) is

characterized by a rugged terrain, strategic international borders, recurring natural disasters, and a history of socio-political unrest. This has always acted as a limitation to development of infrastructure especially the provision of connectivity, and it has led to slow projects, and also reliance on the central funding. But the dynamics of late has changed considerably with the idea of engaging the participation of the private parties to fasten up expanding the network of roads as toll roads using the PPP platform. Several high-profile road infrastructure projects in J&K, such as the Srinagar-Qazigund Expressway, the Chenani-Nashri Tunnel (Dr. Syama Prasad Mookerjee Tunnel), and the Jammu-Udhampur Highway, have been implemented under PPP models. The objectives of these projects are to cut down impressive travel times, have year round connectivity and to promote trade and tourism in the region. Although these projects are substantial improvement, there is a yet unaddressed gap in the literature of what really happened to these projects- whether in the arena of infrastructural performance as well as socio-economic implications of these projects on the locals.

The present study intends to conduct a systematic analysis on the effects of application of Public-Private Partnerships on toll road infrastructure in Jammu and Kashmir based on several parameters including cost velocity, quality of the road, means of transport safety, the efficiency of maintenance works, affordability of tolls and overall user satisfaction. It also aims at knowing the institutional and operational issues that the PPPs encounter in an area of volcanic climate and conflict such as Jammu and Kashmir.Through this, it will have a general framework based on mixed-methods giving credence to the policy-based documents, project-based documents, stakeholder interview, and user surveys. Special focus will be made in the roles and responsibilities of the private partners, the regulatory oversight of the public authorities, the type and the mechanism of risk sharing as well as the long-term sustainability of toll model applied. The implications of this study are likely to give evidence-based advice on how PPP frameworks could be enhanced in inaccessible landscapes and politically volatile regions. Furthermore, the results may be used in the formulation of future policies not only in Jammu and Kashmir but in other states of India and developing nations which seek to adopt PPPs as an infrastructure financing mechanism in the underserved areas. Finally, what has been explored here would hopefully add to the debate on balancing the needs of the people, the companies and the development of the region through proper implementation of PPP.

LITERATURE REVIEW

Public-Private Partnerships in Infrastructure Development

Public-Private Partnerships (PPPs) have evolved as a strategic policy instrument aimed at leveraging private sector resources for public infrastructure development. According to Grimsey and Lewis (2004), PPPs involve long-term contractual arrangements that allocate specific responsibilities and risks to the public and private stakeholders based on their capabilities. The model seeks to enhance project efficiency, service quality, and value for money (Yescombe, 2007; Hodge & Greve, 2007). In developing countries, where infrastructure gaps are wide and public funds are limited, PPPs provide an opportunity to accelerate infrastructure creation without overburdening state budgets (Roehrich et al., 2014). Moreover, studies have shown that PPPs often result in the timely completion of projects and superior operational efficiency compared to traditional public sector models (Zhang, 2005; Liu et al., 2016). However, scholars such as Iossa and Martimort (2015) argue that PPPs can also be complex and prone to renegotiation if risks are not appropriately shared. The insufficient match of the incentive and insufficient control can result in the growth of costs and discontent of the people.

*Hypothesis 1: Provided that, due to the Public-Private Partnerships, more efficiency is achieved during the construction of toll road infrastructure in Jammu and Kashmir***.**

PPPs in the Indian Road Sector

India has embraced PPPs extensively in the road sector, particularly through Build-Operate-Transfer (BOT) and Hybrid Annuity Models (HAM). The National Highways Authority of India (NHAI) has executed numerous projects through these models under the National Highways Development Project (NHDP) and Bharatmala Pariyojana (MoRTH, 2020). Ghosh and Kumar (2013) highlight that PPPs have helped bridge investment gaps, reduce project delays, and enhance road quality in several states. Nonetheless, Kumar and Das (2018) point out recurring challenges such as land acquisition delays, tolling issues, and project cancellations due to poor demand assessment. In states like Maharashtra and Karnataka, some projects have failed due to underperformance and public resistance to toll charges (Chakrabarti & Dhar, 2016; Singh & Mishra, 2019). Despite these concerns, empirical evidence suggests that with transparent concession agreements, proper traffic forecasting, and effective public monitoring, PPPs can deliver significant value (Raghuram, 2015; Jain et al., 2018).

Hypothesis 2: PPP-initiated toll road projects are important in the process of raising the standards of roads and infrastructure in service delivery in India.

Toll Road Infrastructure and User Impact

The PPP models on the toll roads can most likely give a high standard of road facilities and condensed traveling time as compensation to user charges. Studies by Bain (2009) and Button (2006) emphasize the importance of user-centric

outcomes such as road safety, pricing transparency, and travel efficiency. Users' perception of affordability and fairness plays a key role in determining the success of such models (Estache & Serebrisky, 2004). Research in countries like Brazil and China demonstrates that projects with poorly planned toll regimes often face public protests, even when the roads are technically sound (Guasch et al., 2008; Zhang et al., 2013). Similarly, Mallett (2008) notes that road user satisfaction is a critical metric that must be regularly assessed in toll-based PPP projects. In India, toll affordability and grievance redress mechanisms are inconsistently implemented, leading to discontent and protests in some areas (Kumar & Shah, 2021; Singh et al., 2020).

Hypothesis 3: PPPs indicator by toll roads introduced Jammu and Kashmir positively affects the satisfaction level of the users, transfer time, and costs.

PPPs in Conflict-Prone and Geographically Challenging Regions

Though, the policy concern of constructing infrastructure in an area like Jammu and Kashmir that is conflict ridden to begin with and Across rugged topography is however, an interesting policy concern. Aijaz (2011) argues that traditional public sector approaches have largely failed to address connectivity issues in the region due to logistical constraints, harsh weather, and socio-political instability. Emerging PPP models are attempting to bridge this gap. For example, the Chenani-Nashri Tunnel and the Srinagar-Qazigund Expressway were implemented through PPPs and have significantly improved connectivity (Bhat, 2022; Kumar & Shah, 2021). However, these projects also faced delays and cost escalations due to security lockdowns, unpredictable terrain, and difficulties in stakeholder coordination (Ahmed & Wani, 2019; World Bank, 2016). Despite these challenges, adaptive PPP models with flexible risk-sharing provisions have shown promise in similar geographies like Nepal and the Northeastern states of India (Lama & Ghosh, 2020; Shukla, 2019).

Hypothesis 4: The impact of the use of PPPs in the hilly regions like Jammu and Kashmir boosts the manifestation of the physical road facility that is often wounded by circumstantial realities.

Risk Management and Institutional Effectiveness in PPPs

Risk identification, the risk allocation and management processes are also associated with the success of the PPP. Hodge and Greve (2007) note that clearly defined contractual frameworks, regulatory oversight, and institutional capacity are essential to minimize disputes and ensure performance. The Indian experience shows that poorly structured contracts lead to cost overruns and renegotiations (Raghuram, 2015; Mohanty & Das, 2021). Effective regulatory institutions such as the NHAI, Ministry of Road Transport and Highways (MoRTH), and the PPP Appraisal Committee play critical roles in managing these risks. In J&K, the lack of a dedicated PPP cell or regional regulatory authority adds to the complexity of implementation and monitoring (J&K Infrastructure Report, 2020).

Studies by Roehrich et al. (2014) and Estache et al. (2007) recommend strengthening institutional frameworks, especially in politically sensitive and geographically complex regions, to ensure proper contract enforcement and dispute resolution.

Hypothesis 5: Successful institution support and management are also important points, and it is what determines the success and sustainability in PPP toll road projects in Jammu and Kashmir.

RESEARCH METHODOLOGY

Research Design

This study adopts a quantitative, descriptive, and analytical research design to examine the impact of Public-Private Partnerships (PPPs) on toll road infrastructure in Jammu and Kashmir. The descriptive nature of the research also allows for having the complete picture of the state of affairs, but the analytical section of the work makes it more convenient to analyse the relations between the variables, measuring them on the statistical level. What is interesting is how the PPP models have led to the quality of the infrastructure, the experiences of people in the course of the travel, the affordability of the toll, and the satisfaction of the users in the region. The study relies on a positivist paradigm that employs guided and quantitative instruments to verify the hypothesis embraced on the basis of the literature.

Sampling Technique and Sample Size

The research pursues a method of sampling called non-probability purposive technique because it would help in identifying the representatives of individuals directly engaged or the target of toll road infrastructure construction operated on PPP mechanisms.

The sample will have two main categories of samples (general toll road users and key stakeholders). The total sample size of 150 respondents, consisting of 100 road users and 50 stakeholders, was chosen. This size is considered adequate for applying multivariate analysis techniques such as Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM), as recommended by statistical guidelines for SEM with moderate model complexity.

Data Collection Method

Data was collected using a structured questionnaire, which included a series of closed-ended statements measured on a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The designed questionnaire was founded on thorough literature analysis and was confined into a few blocks that refer to the main dimensions of the research: PPP effectiveness, road quality, travel convenience, toll affordability, user satisfaction, and institutional support. A pilot test was executed with 20 respondents before the full-scale data collection began in order to evaluate the effectiveness, thoroughness and accuracy of the instrument, followed by an adjustment of such instrument.

Variables and Measures

To evaluate the impact of Public-Private Partnerships (PPPs) on toll road infrastructure in Jammu and Kashmir, the study focuses on six core constructs that collectively capture the effectiveness and outcomes of PPP-led infrastructure projects. Such constructs are based on the critical synthesis of various literature and were chosen to be applicable in Indian and regional context. The constructs are latent variables and these latent variables are measured in terms of a series of observable indicators within a structured questionnaire. Responses were recorded on a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The latent variables comprise PPP Effectiveness, Road Quality, Travel Convenience, Toll Affordability, User Satisfaction and Institutional Support. The three variables were subsequently measured against reliability and validity through exploratory and confirmatory factor analysis.

Table 1: Description of Variables and Measures

Construct	Definition	Key Indicators	References
PPP Effectiveness	Measures the efficiency and success of PPP implementation in toll road projects.	- Timely completion of projects- Private investment mobilization- Risk-sharing mechanisms- Innovation and quality by private partners- Transparency in PPP execution	Yescombe (2007); Raghuram (2015); Roehrich et al. (2014)
Road Quality	Assesses the physical condition and functional attributes of the road infrastructure.	- Smoothness and durability of road surface- Drainage and road safety infrastructure- Traffic signage- Regular maintenance- Availability of emergency services	Ghosh & Kumar (2013); Kumar & Shah (2021)
Travel Convenience	Evaluates improvements in travel efficiency and connectivity due to PPP toll roads.	- Reduced travel time- Smooth traffic flow- Connectivity to remote areas- Access to key economic centres	Bain (2009); Button (2006)
Toll Affordability	Reflects user perception of toll charges in terms of fairness and value.	- Reasonableness of toll fees- Value for money- Impact on commuters- Affordability across income groups	Estache & Serebrisky (2004); Singh et al. (2020)
User Satisfaction	Captures the overall user experience with PPP-operated toll roads.	- Comfort and safety- Road facilities (signage, rest areas)- Grievance redressal effectiveness- Service staff behaviour- Overall satisfaction	Mallett (2008); Zhang et al. (2013)
Institutional Support	Assesses the role of government and regulatory bodies in supporting PPPs.	- Government policy support- Regulatory monitoring- Contract enforcement- Responsiveness to issues- Administrative stability	Roehrich et al. (2014); Hodge & Greve (2007)

Validity and Reliability

The content validity of the research is ensured by the expertise of the individuals who reviewed the questionnaires, as they are domain experts coming from an infrastructure and a public policy background. Construct validity was also determined by using CFA, where the measured variables matched with their latent dimensions commensurately. Cronbach's alpha was used to check on reliability, and all constructs were above the actual threshold of 0.70, which indicated internal consistency. Composite reliability and Average Variance Extracted (AVE) were also calculated to establish convergent validity, while the Fornell-Larcker criterion was used to check discriminant validity.

Data Analysis Techniques

The collected data was analysed using SPSS (version 25) for initial descriptive and exploratory analysis, and AMOS (version 24) for Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM). The analysis was conducted in multiple phases. Firstly, descriptive statistics (means, standard deviations, frequency distributions) were

used to understand the sample profile and general trends in responses. This was followed by Exploratory Factor Analysis (EFA) to uncover the underlying factor structure among observed variables, using Principal Component Analysis (PCA) with Varimax rotation.

After the EFA confirmed the dimensionality of constructs, Confirmatory Factor Analysis (CFA) was conducted to validate the measurement model and assess construct reliability and validity (including convergent and discriminant validity). Model fit was evaluated using indices such as the Chi-square/df ratio, Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Residual (SRMR).

Finally, Structural Equation Modeling (SEM) was used to test the hypothesized relationships among latent constructs. SEM was appropriate in the study of the complex nature of cause and effect implications of PPP on toll roads since both direct and indirect effects could be analysed at a time. The structural model provided estimates for path coefficients, significance values, and explained variances (R^2) for endogenous variables.

Data Analysis and Interpretation

This chapter presents the results of the statistical analysis conducted to assess the impact of Public-Private Partnerships (PPPs) on toll road infrastructure in Jammu and Kashmir. The analysis is structured into four major sections: Descriptive Statistics, Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM). In each section, a careful explanation of the results is provided in a bid to support the goals of the study.

Descriptive Statistics

Descriptive statistics were used to provide the demographic details of the respondents and the measures of the mean, mode, and median of the variables in the study. This will provide background information about the sample and general trends of the responses.

Demographic Profile of Respondents

A total of 150 respondents participated in the study, comprising 100 general toll road users and 50 stakeholders (including government officials and representatives of private partners involved in PPP projects). The demographic characteristics of the sample are detailed below:

Table 2: Demographic Characteristics of Respondents

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	105	70%
	Female	45	30%
Age	Below 25 years	22	14.7%
	25–35 years	46	30.7%
	36–45 years	52	34.7%
	Above 45 years	30	20.0%
Occupation	Government Employee	28	18.7%
	Private Sector	40	26.7%
	Self-employed/Business	32	21.3%
	Student	18	12.0%
	Others	32	21.3%
Education	Below 12th Standard	24	16.0%
	Undergraduate	53	35.3%
	Postgraduate and above	73	48.7%
User Type	Toll Road User	100	66.7%
	Stakeholder (Govt/PPP)	50	33.3%

Validity and Reliability

To ascertain content validity, consultation of experts in the field that is infrastructure and the public policy domain was done, to review the relevance, coverage, and clarity of the questionnaire. The construct validity was determined by means of CFA, which indicated that the observed variables represented their underlying latent constructs in a proper way.

Cronbach's alpha was used as a relationship measure, and all the constructs surpassed the acceptable value of 0.70, proving that they are internally consistent. Composite reliability and Average Variance Extracted (AVE) were also calculated to establish convergent validity, while the Fornell-Larcker criterion was used to check discriminant validity.

Data Analysis Techniques

The collected data was analysed using SPSS (version 25) for initial descriptive and exploratory analysis, and AMOS (version 24) for Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM). The analysis was conducted in multiple phases. Firstly, descriptive statistics (means, standard deviations, frequency distributions) were used to understand the sample profile and general trends in responses. This was followed by Exploratory Factor Analysis (EFA) to uncover the underlying factor structure among observed variables, using Principal Component Analysis (PCA) with Varimax rotation.

After the EFA confirmed the dimensionality of constructs, Confirmatory Factor Analysis (CFA) was conducted to validate the measurement model and assess construct reliability and validity (including convergent and discriminant validity). Model fit was evaluated using indices such as the Chi-square/df ratio, Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Residual (SRMR). Finally, Structural Equation Modeling (SEM) was used to test the hypothesized relationships among latent constructs. SEM enabled both direct and indirect effect analysis to be applied simultaneously, which is why it was used to examine the PPP influence on toll roads outcomes that can be characterized by a complex causal model. The structural model provided estimates for path coefficients, significance values, and explained variances (R^2) for endogenous variables. The demographic aspect is that there is a good sharing of sample making it balanced in terms of gender, age group, occupation and education level. A large proportion of the respondents were between 25–45 years of age (65.4%), and nearly half held postgraduate qualifications, indicating a fairly educated and experienced sample. Having both toll road users and key stakeholders means the balance when considering performance and governance of the infrastructure when approached through PPP models.

Descriptive Statistics of Study Variables

To understand the perception of respondents regarding various dimensions of toll road infrastructure and services, descriptive statistics (mean and standard deviation) were calculated for six key constructs.

Table 3: Descriptive Statistics of Study Constructs

Construct	No. of Items	Mean (M)	Standard Deviation (SD)	Interpretation
PPP Effectiveness	5	4.20	0.74	High perceived effectiveness of PPPs
Road Quality	5	3.97	0.82	Positive perception of road maintenance and safety
Travel Convenience	4	3.85	0.79	Noted improvement in journey time and access
Toll Affordability	4	3.42	0.87	Mixed views; some affordability concerns
User Satisfaction	5	4.05	0.77	High satisfaction with overall user experience
Institutional Support	5	3.89	0.83	Perceived institutional support was moderately high

Among the six constructs, PPP Effectiveness scored the highest (M = 4.20), indicating that respondents widely perceive the PPP model to have positively contributed to infrastructure development in the region. The construct User Satisfaction also scored high (M = 4.05), reflecting positive user experiences, likely driven by improvements in Road Quality and Travel Convenience. However, Toll Affordability received the lowest mean (M = 3.42), suggesting some public concern about the cost burden, particularly among frequent users. The moderate standard deviations (ranging from 0.74 to 0.87) indicate reasonable variability but no extreme dispersion in responses.

Exploratory Factor Analysis (EFA)

Exploratory Factor Analysis was conducted to identify the latent structure underlying the survey data and verify the factorability of the constructs.

KMO and Bartlett's Test Results:

- Kaiser-Meyer-Olkin (KMO) = 0.861**,** indicating excellent sampling adequacy.
- Bartlett's Test of Sphericity = $\chi^2(435) = 3267.112$, $p < 0.001$, supporting the suitability of data for factor analysis.

EFA Extraction Results:

- Method**:** Principal Component Analysis with Varimax rotation**.**
- Number of Factors Extracted**:** 6 (eigenvalues > 1).
- Cumulative Variance Explained**:** 72.8%**,** indicating high explanatory power.
- Factor Loadings**:** Ranged from 0.62 to 0.87, indicating that items loaded well onto their respective constructs.
- No cross-loadings > 0.40**,** supporting discriminant validity.

EFA confirmed that the items in the instrument grouped logically into six distinct and meaningful factors. The high variance explained (72.8%) and strong factor loadings demonstrate that the constructs are well-structured and statistically valid, supporting the reliability of the conceptual framework.

Confirmatory Factor Analysis (CFA)

A Confirmatory Factor Analysis (CFA) was conducted using AMOS to assess the validity and reliability of the measurement model. Model fit statistics show that the model used in measuring fit the data well. According to the Chi-square/df value of 1.78 as presented in Table 4, the value is less than the recommended 3.00 rating so models fit well. Both the RMSEA value of 0.056 and SRMR value of 0.043 are less than the cut-off value of 0.08 which implies close approximate fit and minimal residual error, respectively.

TABLE 4: Model Fit Indices – Measurement Model

Fit Index	Value	Threshold
Chi-square/df (CMIN/df)	1.78	< 3.00
RMSEA	0.056	< 0.08
CFI	0.951	> 0.90
TLI	0.939	> 0.90
SRMR	0.043	< 0.08

Additionally, the CFI (0.951) and TLI (0.939) exceed the recommended minimum value of 0.90, further confirming a well-fitting model. Table 5 below represents the reliability and validity of every construct. Cronbach's Alpha values ranged from 0.79 to 0.87, and Composite Reliability (CR) values ranged from 0.82 to 0.89, all surpassing the threshold of 0.70, indicating good internal consistency. Average Variance Extracted (AVE) values ranged from 0.52 to 0.64, exceeding the 0.50 benchmark, which confirms adequate convergent validity. On the whole, these findings tend to confirm the reliability and validity of the measurement model that could be successfully utilized in the further structural analysis.

TABLE 5: Reliability and Validity Measures

Construct	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
PPP Effectiveness	0.87	0.89	0.64
Road Quality	0.84	0.87	0.59
Travel Convenience	0.83	0.85	0.56
Toll Affordability	0.79	0.82	0.52
User Satisfaction	0.85	0.88	0.61
Institutional Support	0.81	0.83	0.55

Structural Equation Modeling (SEM)

Structural Equation Modeling (SEM) was employed in this study to test the hypothesized causal relationships between the latent constructs identified in the conceptual framework, namely: PPP Effectiveness, Road Quality, Travel Convenience, Toll Affordability, Institutional Support, and User Satisfaction. The method of SEM is a strong multivariate method that integrates factor analysis and path analysis to systems examine both measurement and structural models at the same time. It was aimed at confirming the correlations between these constructs and the overall goodness-of-fit of a given proposed model.

Table 6: Goodness-Of-Fit

Fit Index	Value	Threshold
Chi-square/df (CMIN/df)	1.92	< 3.00
RMSEA	0.061	< 0.08
CFI	0.947	> 0.90
TLI	0.932	> 0.90

Structural Equation Modeling (SEM)

The Structural Equation Modeling (SEM) output presented below confirms that all the hypothesized relationships in the conceptual framework were supported at a high level of statistical significance ($p < 0.001$). The standardized regression weights (β), critical ratio (CR or t-value), and p-values all indicate strong causal associations among the key constructs in the model. Below is the tabulated summary, followed by a detailed interpretation:

Table 7: Path Coefficients and Hypothesis Testing

Hypothesis	β	CR (t-value)	p-value	Result
H1: PPP Effectiveness → Road Quality	0.61	7.625	<0.001	Supported
H2: PPP Effectiveness → Travel Convenience	0.58	6.441	<0.001	Supported
H3: PPP Effectiveness → Toll Affordability	0.42	3.819	<0.001	Supported
H4: Road Quality → User Satisfaction	0.51	7.286	<0.001	Supported
H5: Institutional Support → User Satisfaction	0.38	4.221	<0.001	Supported
H6: Travel Convenience → User Satisfaction	0.43	5.375	<0.001	Supported
H7: Toll Affordability → User Satisfaction	0.34	3.400	0.001	Supported

Explained Variance (R^2 Values)

- Road Quality**:** 37%
- Travel Convenience**:** 34%
- Toll Affordability: 26%
- User Satisfaction: 64%

These SEM findings verify all the proposed hypotheses, which proves that PPP effectiveness has a statistically significant effect on all three important service outcomes. These results, in turn, are associated with high predictability of user satisfaction, as well as institutional support. The amount of variance in user satisfaction accounted by the model is significant at 64 percent. It confirms the conceptual framework and shows the prominence of PPPs in enhancing the infrastructure quality and perception among its users in Jammu and Kashmir.

SUMMARY OF FINDINGS

This study set out to assess the impact of Public-Private Partnerships (PPPs) on toll road infrastructure in Jammu and Kashmir, with a focus on understanding how PPP-led projects influence service quality dimensions such as road quality, travel convenience, toll affordability, and ultimately, user satisfaction. The study used a structured questionnaire administered to 150 respondents, including general toll road users and key stakeholders, and employed a combination of descriptive statistics, Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM) to analyze the data. The descriptive findings revealed that respondents generally viewed PPP projects positively, with PPP Effectiveness receiving the highest average rating (Mean = 4.20), followed closely by User Satisfaction (Mean = 4.05) and Road Quality (Mean = 3.97). These scores imply that most of the participants underwent significant changes in infrastructure and service delivery. However, Toll Affordability had a lower average score (Mean = 3.42), indicating a moderate level of concern regarding the cost of tolls among users.

The conceptual model was proved to be well founded through the EFA results of its validation that verifies the existence of six distinctive and significant constructs having large loadings as well as free of cross-loadings. The CFA results further supported the model's construct validity, with all fit indices falling within acceptable thresholds, and the constructs showing strong internal consistency (Cronbach's α ranging from 0.79 to 0.87), composite reliability, and convergent validity (AVE > 0.5). All the seven hypotheses in the study were corroborated in the SEM analysis. The analysis proved that the PPP Effectiveness significantly and positively influence Road Quality, Travel Convenience, and Toll Affordability. The latter, in its turn, were found to have a positive effect on User Satisfaction. Also, the Institutional Support was also found to be a very important positive variable contributing to the overall satisfaction. The model depicted 64 per cent of the variances in User Satisfaction which is a high explanatory power and that the variables when taken together provide a whole view of how PPPs influence on public perception and outputs of service. Also, in demographic analysis, the sample of the respondents was revealed to be heterogeneous in age, gender, education, and occupation. A high percentage of the population surveyed belonged to the working population, and a high percentage belonged to graduate and postgraduate degree holders, which could have led to more informed responses on the matters of infrastructure and governance.

CONCLUSION

This study is an absolute evaluation of the fact that Public-Private Partnerships have played a significant role in the construction and the performance of the toll road infrastructure in Jammu and Kashmir. The findings of the study verify the fact that, physical road conditions, travel convenience, and user satisfaction enhance when modeled and implemented adequately, the PPP model approach to the development of road construction. The benefits are especially high in an area such as Jammu and Kashmir because the topographical problems, the security issues, and the administrative limits have always hindered infrastructure developments. Among the central findings of the research, it is possible to report that PPP Effectiveness is not merely a project delivery thing, but it is also a user-based final. The success of a PPP project should hence not just be gauged by its financial closure or even construction schedule, but also the satisfaction of the people to the performance of such a venture, the quality of the services and even the affordability thereof in the long term.

The research paper also sheds lights on how crucial Institutional Support is within the PPP industry. Effective regulatory mechanisms, monitoring mechanisms, and responsive public institutions are essential in making sure that facilities developed with the involvement of the private sector have the capacity of achieving sustainable and inclusive outcomes of infrastructure development. Even PPPs well-funded would not achieve their potential without well-established positive institutions of the people. Nevertheless, there is a red flag in the study when it comes to affordability of tolls as it was the least scored variable of the constructs. It implies that although the roads are likely to be of a high quality and the trip is likely to take less time, there is a cost to the end-users, which needs to be countered by either applying more comprehensive policies or pricing. Conclusively, the study not only proves the point that PPPs speed up the process of infrastructure construction in complex areas but it also generalises a guide on how to come up with equitable, efficient and sustainable PPPs. It highlights the necessity of having a means of integrating all of this with the engineering excellence, financial viability, orientation of users and institutional accountability so that in the long run and at various places the PPP initiatives in India are successfully achieved.

Managerial Implications

The implications of this study offer with essential and incisive information to policy-makers, infrastructure operators, and private financiers and government administrators participating in the PPP underpinned road infrastructure establishment. Among the implications on the managerial side, the necessity to lay emphasis on user-cantered planning and design in PPP agreements is evident. The research also found out that user satisfaction significantly depends on the variables like quality of road, convenient travelling, affordability of tolls, and institutional strengths. This implies that, service delivery success in PPP projects need to exceed the physical realization and entail sustained service delivery, open operations, and affordability to different categories of users. Both the government and the corporate sector managers should prioritize on performance contracts of PPP which encompasses performance indicators on service delivery e.g. average journey time reduction, longevity of road surface and customer grievance/redressal rates. The contracts should have these metrics imbedded on them and should be assessed by independent audits. Furthermore, more affordable toll prices were also lower, meaning that the strategy of tiered prices should be implemented by project managers, or possible government subsidies on regular commuters or those who are not financially stable. These measures can facilitate inclusion and equitability of accessing infrastructure services.

The guidelines compiled by institutional actors particularly the ones belonging to the public sector should include effective measures of governance such as transparent procurement procedures, efficient dispute resolution procedures and the involvement of the populace in planning procedures. The paper points out institutional support as strengthening influence of user satisfaction; therefore, government institutions should not only just help but also control the functioning of the privates to ensure the accountability factor. Improved capacity building of PPP management units at state and district level especially in conflict sensitive areas or mountainous states like Jammu and Kashmir is also required where the problems are context-specific and unique. The study also advises managers should consider systems

thinking in planning and assessing PPPs and that all these and how well they interlock with road infrastructure, local economic development, regional connectivity and citizen wellbeing should be put into consideration. Regular stakeholder feedback, community engagement programs, and use of technology for monitoring (like GIS and IoT-based sensors) can further enhance service delivery and foster public trust in PPPs.

Limitations of the Study

Although such research adds a lot of value in terms of understanding the PPP performance especially when it comes to the development of toll roads, some limitations ought to be raised to place the findings into perspective. On the one hand, it is limited by geographical scope as it considers a specific region of India, Jammu and Kashmir only, and therefore, may not have a direct implication in other states of India as well as abroad. The unique socio-political and topographical conditions in Jammu and Kashmir (e.g., security concerns, remote terrain, and policy transitions) differentiate it from more stable or accessible regions. Hence, to determine the external validity of the model, the replication of the model in other settings is required.

Second, the sample group of 150 respondents is statistically sufficient to conduct SEM, but it does not necessarily reflect the number of various types of stakeholders and their range of experiences and perceptions, and in particular, road contractors, city planners, and underprivileged groups of people, such as women, the aging, or the disabled. In addition, the share of stakeholder types was skewed, where most of them were user-related, and a significant minority category was the government or the PPP partner, a fact that can alter the balance in the perception.

Third, the cross-sectional information does not allow to reach conclusions about causality or temporal changes. The inability to know how perceptions of PPP effectiveness and satisfaction develop over the time frame of a particular project is because data was taken at one point when a project was in its existence. Appendix I may offer more active data about performance surveillance and citizen contentment through a longitudinal methodology. Lastly, the research is based on self-reporting which is prone to social desirability bias, response fatigue and a memory error in cognitive recall of experiences. Perceptions may be influenced by recent events (such as traffic jams or toll hikes) rather than long-term assessments, and respondents may overestimate or underestimate certain service features based on subjective biases.

Directions for Future Research

Based on the limitations and the conclusion of this research study, some interesting opportunities can be identified to extend and widen the knowledge on PPP performance in infrastructure development in the future studies. To begin with, longitudinal research must be conducted in order to follow up over time changes in user satisfaction, quality in the road, as well as effectiveness of the institution. As PPP projects are typically implemented over long durations (10–30 years), it is vital to understand how user experience evolves from the construction phase through operational maturity, and how private partners adapt to new challenges during this period. Secondly, future research on regional compared cases studies be conducted especially between Jammu and Kashmir and other Indian states where PPPs have been inserted into the road or transport infrastructure. With a comparative approach, it would be possible to perform benchmarking, learn across facilities, and determine best practices. It would also assist in determining the contextual nature of findings or evidences of overall patterns in the system of PPP performance.

Third, the researchers are to strive to incorporate both methods by employing the mixed-method designs. Although SEM provides strong statistical inferences, more of the stories, politics, and user-specific issues can be discovered by conducting in depth interviews, field observations, and focus group discussions with the stakeholders and the users of the service or product that quantitative instruments might not reveal. Moreover, future studies can include financial and technical performance indicators, such as cost overruns, toll revenue, internal rate of return (IRR), and average vehicle speed, to complement perception-based data. An appraisal of the value of money and economic efficiency of PPPs would give a more wholesome analysis of the project's performance and sustainability.

The other significant direction is the inclusion of newly emerged topics, namely, environmental sustainability, digital integration, and climate and war-related disruption resilience. As road infrastructure becomes increasingly exposed to environmental risks (e.g., landslides, floods), PPP models must evolve to include sustainability and risk-sharing mechanisms. The study of the behaviour of PPP to overcome such shocks will be helpful in policy design in the future. And finally, one should sort out the gap between the perception of the population and the reality of the technical performance by triangulation methods. Any in congruency between the perceived satisfaction and audited performance may identify the critical vacuum in liaison, belief, or user training that has to be filled.

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