



Critical Factors in Road Infrastructure Investment Effectiveness : A Study in Dong Phu District, Binh Phuoc Province

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ABSTRACT

This study aims to evaluate the effectiveness of road infrastructure investment projects in Dong Phu District, Binh Phuoc Province, from 2020 to 2023. The research adopts a comprehensive methodological approach, incorporating descriptive statistical analysis, Cronbach's Alpha, KMO, and Bartlett's tests, and multiple linear regression models to identify key determinants of project success. Data were collected through surveys involving 105 employees in the transportation and construction sectors, complemented by secondary data from local reports. The findings reveal that investment capital mobilization and management are the most significant factors influencing project outcomes, with a standardized coefficient (Beta) of 0.449. Other critical determinants include the planning and development of the transportation sector (Beta = 0.433), the performance of the project owner and management board (Beta = 0.396), and quality management of road construction projects (Beta = 0.255). These results underscore the need for innovative financial mechanisms, strategic planning, and enhanced management practices to ensure the long-term effectiveness and sustainability of infrastructure investments. The study contributes valuable insights for policymakers and stakeholders, offering practical recommendations to improve the planning, execution, and management of road infrastructure projects in developing regions like Dong Phu District.

Keywords: Transportation Infrastructure, Investment Effectiveness, Project Management, Capital Mobilization, Strategic Planning

I. INTRODUCTION

The rapid development of infrastructure, particularly in the transportation sector, is crucial for fostering

socio-economic growth in developing regions [1-5].

In Vietnam, the government has prioritized the construction and improvement of road networks as a

means to stimulate economic development and reduce poverty in rural and semi-urban areas. Dong Phu District in Binh Phuoc Province is a region undergoing significant transformation, with infrastructure development playing a central role in its economic strategy. The district's location, which connects the Southeastern provinces with the Central Highlands, makes its transportation system vital for the smooth flow of goods and the development of industrial zones “Fig. 1”. However, despite considerable investments, the region still faces challenges related to the effectiveness of these infrastructure projects, particularly in terms of capital mobilization, project management, and long-term sustainability [6-8].

The primary objective of this research is to evaluate the factors influencing the effectiveness of road infrastructure investment projects in Dong Phu District during the period from 2020 to 2023. By employing a comprehensive approach that includes statistical analysis of survey data and regression models, this study aims to identify the key determinants that contribute to or hinder the success of these projects. Understanding these factors is crucial for developing strategies that enhance the overall efficiency of infrastructure investments, thereby contributing to the district's socio-economic development.

The significance of this research lies in its potential to provide actionable insights for policymakers, project managers, and other stakeholders involved in infrastructure development. By shedding light on the challenges and opportunities within the current investment framework, this study not only contributes to the academic literature on infrastructure management but also offers practical recommendations that can be implemented to improve the planning, execution, and sustainability of infrastructure projects in similar contexts.

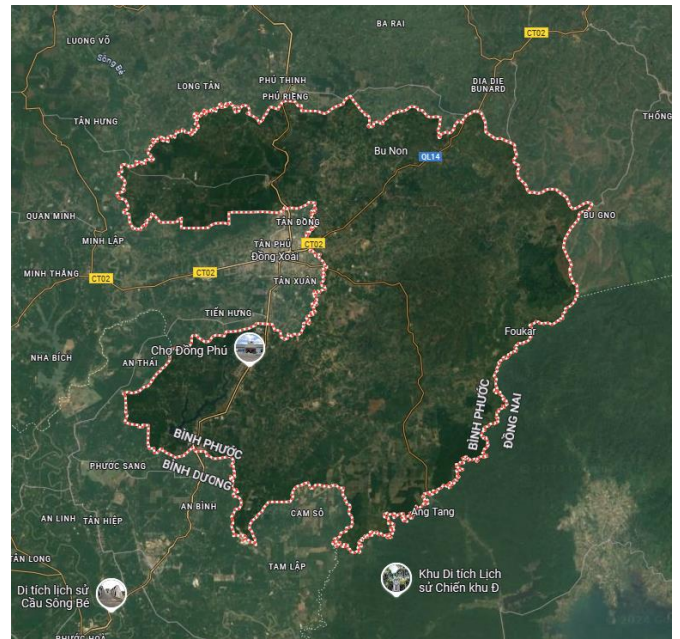


FIG. 1. LOCATION OF DONG PHU DISTRICT, BINH PHUOC PROVINCE

II. MATERIALS AND METHOD

The study focuses on the road transportation system in Dong Phu District, Binh Phuoc Province during the period 2020-2023. This is a crucial period to assess the effectiveness of construction investment and infrastructure management activities in this locality. To conduct the research, we collected data from various sources. Secondary data were obtained from official local reports, including reports on socio-economic conditions, infrastructure development plans, and other related documents. Additionally, we conducted a survey with 105 employees involved in the transportation and construction sectors in Dong Phu District “Fig. 2”. This survey was designed to gather detailed information on indicators related to quality, investment efficiency, and factors affecting the management and operation of transportation infrastructure (Table I).

The data analysis methods in this study include a range of statistical techniques to ensure the accuracy and reliability of the results. We used descriptive statistical analysis to summarize and analyze the basic

characteristics of the collected data . To assess the reliability and consistency of the survey indicators, we applied Cronbach's Alpha method, a widely used technique for evaluating the reliability of measurement scales. Additionally, KMO (Kaiser-Meyer-Olkin) and Bartlett's Test were also employed to check the suitability of the data for factor analysis, thereby identifying the structure of variables and the relationships between them [9, 10].

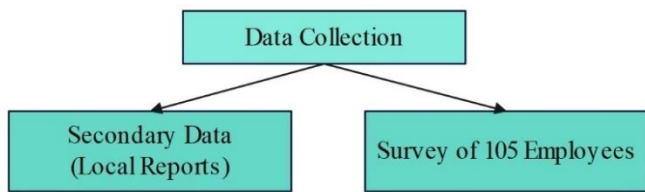


FIG. 2. DATA COLLECTION PROCESS

To evaluate different scenarios regarding funding sources, investment options, and operational management, we developed a forecasting model using multiple linear regression “Fig. 3” [11, 12]. This model allows us to analyze and predict the impact of independent variables on the dependent variable, thereby identifying the most significant factors affecting investment effectiveness and infrastructure management in Dong Phu District. The results from this model not only clarify causal relationships but

also provide a scientific basis for making appropriate policy recommendations to enhance the effectiveness of road construction investment and management in the future.

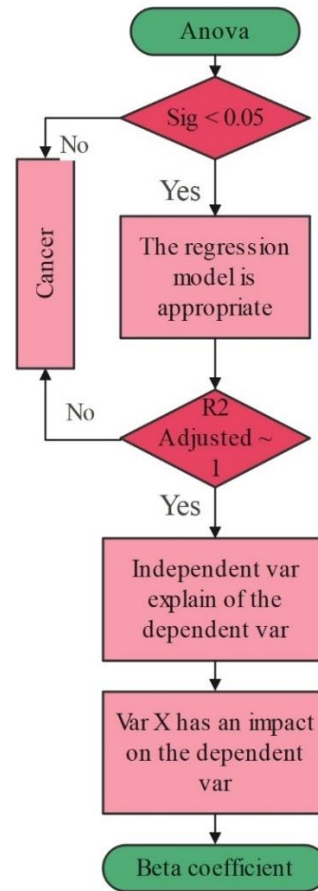


FIG. 3. REGRESSION ANALYSIS PROCESS

TABLE I. Content of the Investment Effectiveness Evaluation Survey (the 1-5 Likert scale)

Category	Item	Description
Planning and Development of Transportation Sector	Planning_1	How do you evaluate the suitability of the transportation sector development plan in Dong Phu district in meeting current transportation needs?
	Planning_2	Does the transportation sector development plan in Dong Phu district consider socio-economic development and environmental protection factors?
	Planning_3	In your opinion, is the transportation sector development plan in Dong Phu district implemented according to the proposed schedule and progress?
Performance of Project Owner and Management Board	Execution_1	How do you evaluate the management and operational capacity of the Project Owner (CĐT) and Project Management Board (BQLDA) in transportation projects?
	Execution_2	How effective is the Project Owner and Project Management Board in coordinating with related parties to execute transportation

		projects?
	Execution_3	How well do the Project Owner and Project Management Board handle issues that arise during the project implementation process?
Quality Management of Road Construction Projects	Quality_Management_1	How do you evaluate the quality of road transportation projects in Dong Phu district after completion?
	Quality_Management_2	How is the supervision and inspection of quality during the construction of road transportation projects conducted?
	Quality_Management_3	How well do road transportation projects in Dong Phu district meet technical standards and safety requirements?
Investment Capital Mobilization and Management	Capital_Management_1	How do you evaluate the ability to mobilize investment capital for transportation projects in Dong Phu district?
	Capital_Management_2	How effective is the management and use of investment capital for transportation projects in Dong Phu district?
	Capital_Management_3	How transparent is the management and use of investment capital for transportation projects in Dong Phu district?
Overall Effectiveness of Road Infrastructure Projects	Effectiveness_1	How do you evaluate the improvement of road infrastructure after investment projects in Dong Phu district?
	Effectiveness_2	How effective are road infrastructure investment projects in promoting socio-economic development in Dong Phu district?
	Effectiveness_3	What is the level of public satisfaction with road infrastructure investment projects in Dong Phu district?

III. RESULTS

During the study on the current state of transportation infrastructure in Dong Phu District, Binh Phuoc Province, we collected and analyzed data to assess the quality of roads, budget allocation, and management operations (Table 2). Dong Phu District, located in the midland and mountainous area of Binh Phuoc Province, holds a strategic position, being 13 km away from Dong Xoai City and 90 km from Ho Chi Minh City. This location provides favorable conditions for the district's connectivity and socio-economic development.

By 2023, the transportation system in Dong Phu District had seen significant improvements. The district now has 773 routes with a total length of 1,309.3 km, including urban roads, district roads, and communal roads. Notably, the urban road system has

a length of 97.92 km, of which 21.72 km is made of concrete, 40.96 km of asphalt concrete, and 28.15 km of surface dressing. The district road system spans 180.07 km, with 5.5 km made of concrete, 82.54 km of asphalt concrete, and 57.15 km of surface dressing. Meanwhile, the communal road system covers 1,031.31 km, including 308.71 km of concrete roads, 11.7 km of asphalt concrete roads, and 327.89 km of surface dressing roads.

Despite significant efforts to upgrade and expand the transportation system, many roads in Dong Phu remain in a state of deterioration, unable to meet the increasing demand for transportation. Particularly, key roads like DT741 and National Highway 14, which connect the Southeastern provinces with the Central Highlands, still require improvement to ensure the smooth flow of goods and the development of industrial zones.

TABLE II

Summary of data on the transportation system in Dong Phu District

Road Type	Total Number of Routes	Total Length (km)	Classified by Road Surface Type (Km)					
			Concrete	Asphalt Concrete	Surface Dressing	Gravel Surface	Earth	Other
Urban Roads	109	97.92	21.72	40.96	28.15	7.09		
District Roads	18	180.07	5.5	82.54	57.15	34.88		
Communal Roads	646	1,031.31	308.71	11.7	327.89	383.01		
Total	773	1,309.30	335.93	135.2	413.2	424.98	0	0

The transportation infrastructure has also significantly supported the district's economic development, with the establishment and expansion of major industrial zones such as the Bac Dong Phu Industrial Zone and the Nam Dong Phu Industrial Zone. However, the lack of investment capital has hindered the upgrading and maintenance projects for the roads. To address this issue, Dong Phu District has implemented measures to mobilize funds from the state budget, while also seeking support from international capital sources.

The management and maintenance of the transportation system also face many challenges, especially during the rainy season. The district has begun applying new technologies in road management and maintenance, such as remote monitoring systems and road asset management software. However, limitations in human resources and funding remain significant obstacles. Measures such as increasing private sector participation through public-private partnership (PPP) models have been implemented, but their effectiveness still requires time to be verified.

The survey results from 105 relevant employees (Table III). The evaluated indicators include the planning and development of the transportation sector, the performance of the Project Owner and the Project Management Board, the mobilization and

management of construction investment capital, as well as the quality management of road construction projects, and the overall effectiveness of road infrastructure projects. These survey results have provided valuable insights into the effectiveness and current challenges in the implementation of transportation projects in Dong Phu District

The results of the Cronbach's Alpha analysis (Table IV) show that the internal reliability of the scales in the study varies. The scale for 'Investment Capital Mobilization and Management' has the highest reliability with a Cronbach's Alpha value of 0.909, reflecting strong consistency among the related questions. Similarly, the scale for 'Quality Management of Road Construction Projects' achieved 0.865, and the scale for 'Performance of Project Owner and Management Board' reached 0.846, both indicating very good reliability.

TABLE III

Description of Survey Participants

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Female	39	37.1	37.1	37.1
Male	66	62.9	62.9	100.0
From 1 to 3 years	29	27.6	27.6	27.6
From 3 to 5 years	31	29.5	29.5	57.1

From 5 to 8 years	40	38.1	38.1	95.2
Over 8 years of experience	5	4.8	4.8	100.0
Office	23	21.9	21.9	21.9
Construction site	82	78.1	78.1	100.0
From 5 to under 10 million VND	25	23.8	23.8	23.8
From 10 to under 15 million VND	41	39.0	39.0	62.9
From 15 to under 20 million VND	34	32.4	32.4	95.2
20 million VND and above	5	4.8	4.8	100.0
College	24	22.9	22.9	22.9
University	49	46.7	46.7	69.5
Postgraduate	32	30.5	30.5	100.0

In contrast, the scales for 'Planning and Development of Transportation Sector' and 'Overall Effectiveness of Road Infrastructure Projects' have Cronbach's Alpha values of 0.614 and 0.665, respectively, indicating an acceptable but not high level of reliability.

In the EFA factor analysis (Table V), the KMO and Bartlett's Test coefficient = 0.680 > 0.5 for the independent variables, concluding that factor analysis is appropriate for the observed variables. The Sig. coefficient = 0.000 < 0.05 indicates statistical significance.

Table IV
Cronbach's Alpha

Valid	Cronbach's Alpha
Planning and Development of Transportation Sector	0.614
Performance of Project Owner and Management Board	0.846

Quality Management of Road Construction Projects	0.865
Investment Capital Mobilization and Management	0.909
Overall Effectiveness of Road Infrastructure Projects	0.665

Table V
KMO and Bartlett's Test (Independent Observed Variables)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.680
Bartlett's Test of Sphericity	Approx. Chi-Square	586.077
	df	66
	Sig.	0.000

The total variance explained is 75.579% > 50%, indicating that the EFA model is appropriate, and the Eigenvalues = 1.455 > 1 confirms that no observed variables were eliminated (Table VI)

Table VI
Total Variance Explained (Independent Observed Variables)

No	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	T	% Var	Cum %	Total	% Var	Cum %
1	3.11	25.927	25.927	3.11	25.927	25.927
2	2.45	20.444	46.372	2.453	20.444	46.372
3	2.05	17.083	63.454	2.050	17.083	63.454
4	1.45	12.125	75.579	1.45	12.125	75.579

Table VII
KMO and Bartlett's Test (Dependent Observed Variables)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.542
Bartlett's Test of Sphericity	Approx. Chi-Square	73.087
	df	3
	Sig.	0.000

The KMO and Bartlett's Test coefficient = 0.542 > 0.5 and Sig. = 0.000 < 0.05 indicates that the dependent observed variable is appropriate (Table VII).

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.413	4	1.353	42.719	0.000 ^b
	Residual	3.168	100	0.032		
	Total	8.582	104			

Table VIII

Total Variance Explained (Dependent Observed Variables)

No	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	T	% Var	Cum %	Total	% Var	Cum %
1	1.854	61.786	61.786	1.854	61.786	61.786
2	0.828	27.589	89.375			
3	0.319	10.625	100.000			

The main part explains 61.786% of the total variance, and the Initial Eigenvalues coefficient is 1.854 > 1 (Table VIII), indicating that they have a good representation of the original data. The results of the multiple linear regression analysis show an Adjusted R Square of 0.616 “Fig. 4”, explaining that the accuracy of the regression model reaches 61.6% (Table IX).

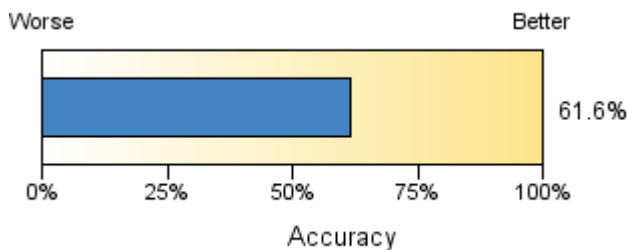


FIG. 4. THE ACCURACY OF THE REGRESSION MODEL

Table IX. Model Summary

Model	R	R Square	Adjusted R Square	Std. Err. Est
1	0.794 ^a	0.631	0.616	0.17799

Table X. ANOVA

With an F value of 42.719 and a significance level (Sig.) of 0.000, the regression model is highly statistically significant, indicating that the predictor variables have a substantial impact on the overall effectiveness of road infrastructure investment projects (Table X).

According to Table XI, the model predicting the overall effectiveness of construction investment is as follows :

$$\text{Overall Effectiveness} = 1.098 + 0.177(X1) + 0.165(X2) + 0.092(X3) + 0.257(X4)$$

Where: X1 is the Evaluation of the Planning and Development of the Transportation Sector; X2 is the Evaluation of the Performance of the Project Owner and Management Board; X3 is the Evaluation of Quality Management of Road Construction Projects; X4 is the Evaluation of Investment Capital Mobilization and Management (according to the Likert scale from 1 to 5)

Table XI. Coefficients

Model		Unstandardized Coefficients		Std. Coef	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.098	0.218		5.040	0.000
	Planning and Development of Transportation Sector	0.177	0.026	0.433	6.844	0.000

Performance of Project Owner and Management Board	0.16 5	0.026	0.39 6	6.40 8	0.00 0
Quality Management of Road Construction Projects	0.09 2	0.022	0.25 5	4.08 8	0.00 0
Investment Capital Mobilization and Management	0.25 7	0.036	0.44 9	7.23 7	0.00 0

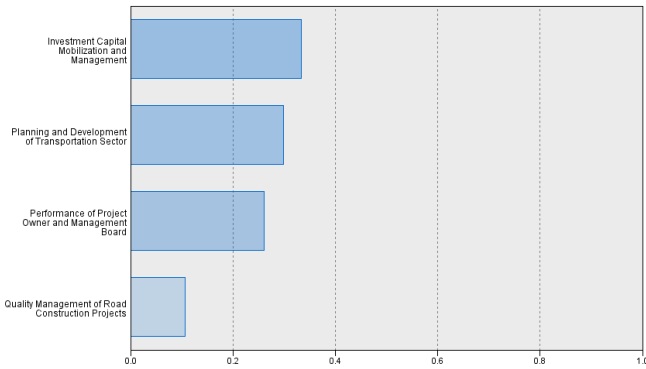


FIG. 5. THE IMPORTANCE OF THE INDEPENDENT OBSERVED VARIABLES TO THE OVERALL EFFECTIVENESS

The most significant factor is Investment Capital Mobilization and Management, followed by the factors Planning and Development of the Transportation Sector; Performance of the Project Owner and Management Board; and Quality Management of Road Construction Projects “Fig. 5”.

IV. DISCUSSION

The analysis of the factors influencing the effectiveness of road infrastructure investment projects in Dong Phu District has revealed several

critical insights. The most significant factor identified in this study is the mobilization and management of investment capital, which aligns with the regression analysis results, showing a standardized coefficient of 0.449. This finding underscores the paramount importance of securing sufficient and well-managed financial resources to ensure the successful implementation of infrastructure projects. The limited availability of capital has been a persistent challenge, as evidenced by the regression model’s adjusted R Square of 0.616, indicating that the financial factor alone can explain a substantial portion of the variance in project effectiveness. This result is consistent with previous studies, such as Makhosheva et al. (2019), who also identified capital mobilization as a crucial determinant of infrastructure project success in similar contexts.

In comparison with earlier research, this study further highlights the role of planning and development in the transportation sector, which had a significant impact, with a standardized coefficient of 0.433. While previous studies often emphasized the technical aspects of project execution, this research brings to light the strategic importance of robust planning that aligns with socio-economic goals and environmental sustainability. The findings suggest that when the planning phase is comprehensive and considers long-term development trajectories, the resulting infrastructure is more effective and resilient.

Additionally, the performance of the project owner and the management board was identified as another critical factor, with a standardized coefficient of 0.396. This indicates that the operational capacity and the ability to coordinate effectively with stakeholders play a crucial role in ensuring project success. This aspect has been less emphasized in earlier studies, which primarily focused on external factors such as funding and environmental challenges. The current

study, therefore, contributes a more nuanced understanding of the internal management practices that drive project success.

In light of these findings, several policy recommendations are proposed. Firstly, there is a need for more innovative financial mechanisms, such as public-private partnerships (PPP), to enhance the mobilization of investment capital. This approach has been shown to be effective in other regions and could help address the funding challenges identified in Dong Phu District. Secondly, improving the planning process by incorporating comprehensive impact assessments and long-term forecasting could enhance the alignment of infrastructure projects with broader socio-economic objectives. Lastly, strengthening the capacity of project management teams through targeted training programs and better coordination practices would ensure that these teams are well-equipped to handle the complexities of infrastructure projects, ultimately leading to more effective project outcomes.

V. CONCLUSION

This study has provided a comprehensive analysis of the factors influencing the effectiveness of road infrastructure investment projects in Dong Phu District, Binh Phuoc Province, during the period from 2020 to 2023. The findings underscore the critical role of investment capital mobilization and management, which emerged as the most significant factor, with a standardized coefficient (Beta) of 0.449 and a t-value of 7.237, highlighting its strong impact on project outcomes. The analysis also revealed the importance of strategic planning and development within the transportation sector, which had a standardized coefficient of 0.433, demonstrating that meticulous and forward-thinking planning is essential for successful infrastructure projects. Furthermore, the study identified the performance of

the project owner and management board as a crucial factor, with a standardized coefficient of 0.396, emphasizing the need for effective coordination and management in project implementation. Lastly, the quality management of road construction projects was found to play a vital role in ensuring the longevity and effectiveness of the infrastructure, with a standardized coefficient of 0.255.

The model predicting the overall effectiveness of construction investment is as follows:

$$\text{Overall Effectiveness} = 1.098 + 0.177(X1) + 0.165(X2) + 0.092(X3) + 0.257(X4)$$

The contributions of this research are twofold. First, it provides empirical evidence on the key determinants of infrastructure project success in a developing region, offering valuable insights for policymakers and practitioners involved in infrastructure development. Second, the study introduces a more nuanced understanding of the internal management practices that significantly influence project outcomes, which has been less emphasized in previous studies. By integrating both external factors like capital mobilization and internal management aspects, this research offers a more holistic view of what drives effective infrastructure development.

Future research should build upon these findings by exploring additional variables that may affect infrastructure project success, such as environmental sustainability practices and the role of technological innovation in project management. Additionally, longitudinal studies that track the long-term impacts of infrastructure investments on socio-economic development in the region would provide further insights into the sustained effectiveness of these projects. Expanding the scope to include comparisons with other regions would also help to generalize the findings and offer broader policy implications.

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