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Prioritising Parameters for Successful Implementation of Value Capture Mechanism - An Indian Urban Projects

S. S. Bhagat[1*], R. M. Tailor[2]

[1*]Research Scholar, Department of Civil Engineering, Sardar Vallabhbhai National Institute of Technology, Surat, India
[2]Ph.d. in Civil Engineering, Department of Civil Engineering, Sardar Vallabhbhai National Institute of Technology, Surat, India

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Abstract
Value capture refers to the process of capturing a portion of the increase in property value resulting from public investments in infrastructure projects. It is an important tool for financing and sustaining urban development. This research paper presents a qualitative approach for value capture mechanism (VCM) in context to urban project. This study consists of parameter prioritisation with respect to revenue generation is studied using fuzzy analytic hierarchy process (FAHP), a multi-actor multi-criteria analysis approach is adopted. It is found that, administrative parameters, infrastructure parameters, geographical parameters, business parameters have criteria weights 0.38, 0.22, 0.19, 0.13 respectively. The research aims to propose appropriate VCM which can potentially contribute towards the investment cost of the urban project.

Keywords: Value Capture Mechanism, Prioritisation, Fuzzy Analytic Hierarchy Process, Global weight

1.Introduction

The overall goal of urban planning is to manage land development and usage for the public benefit. When the government improves its current infrastructure, it brings in new businesses and residents. As a result, the value of land and property rises. The potential growth in land value encircling public infrastructure provides a significant opportunity for cities to foster development while also allowing governments to acquire part of the wealth produced through various value capture (VC) strategies. By putting a tax on the property or mandating an in-kind contribution, such as land or renovations, VC is a public financing strategy that 'captures' an element or all of the rises in land values that occur from extra public investment (Horne et al., 2014). The greater funds can be utilized to fund infrastructure, promote financial and city developments with poverty alleviation programs. The use of value captures mechanisms (VCM) is an answer to city undertaking finance; thus, financing is gaining traction in the number of cities (David et al., 2022).

The fundamental tenet of Value Capture (VC) is that a new infrastructure project—like a motorway or railway line—creates economic value, and that a portion of this value increase can be leveraged to provide funding to augment the project's value. This is according to the Australian Department of Infrastructure and Regional Development (DIRD). Although the method focuses on transportation infrastructure, it might also be applied to health and education infrastructure. (Abelson, 2018). The modern-day study majorly offers mixed factors with advantage capitalization, value restoration with renewable parameters. The method presented in the present study affords treasured perception into the extraordinarily vital issue of financing via VC. VC techniques operate under the idea that public investment frequently consequences in the elevated valuation of private land and actual estate (Davis, 1963). 'Capturing' the subsequent price growth, governments are capable of getting well budget, which could in the end be used to generate an extra value for communities.

Liu et al. (2019) used the system dynamics model to simulate the VCM. Among all recipients, property owners are the ones who benefit the most. If governance systems can support the necessary procedures, Land Value Capture (LVC) could help Public-Private Partnership (PPP) urban rail projects become financially and socially viable (Sharma and Newman, 2018). A reliable tool for evaluating various VCF mechanisms for urban transportation infrastructure is the Multi-Actor Multi-Criteria Analysis (MAMCA) (Roukouni et al., 2018). The evaluation of transportation investments in the literature also use multi-criteria decision-making (MCDM) techniques (Yücel and Taşabat, 2019). The viability of VC depends on

its capacity to finance or fund certain components of a transit project, local infrastructure, or other public needs (Page et al., 2016). The findings of the study by Keyvan Ekbatani and Cats (2015) are crucial for guiding planning choices and setting priorities for actions to enhance public transportation. Zhou et al. (2017) built the evaluation system for gate capacity of urban rail traffic. Additionally, VC is commonly employed for transit applications both domestically and internationally (Vadali et al., 2009). It is established that the Mumbai Metro Rail system has a 75% success rate with satisfactory outcomes in the service, quality, and societal sectors (Jasti and Vinayaka Ram, 2019). VC techniques may present a chance to accomplish the targeted objectives (Samsura and van der Krabben, 2011). Building Information Modeling (BIM) technology, which is now mostly underutilised, can successfully resolve technical issues in the metro rail transit project (Liu and Sun, 2018). Residential sales prices and commutes to the Philadelphia Central Business District (by car or Lindenwald Line passenger) are indicators of the VCM (Allen, 1987).

2.Literature review

The literature presents a methodological framework offering significant flexibility for adding values to quantitative criteria and revisiting the analysis in the event of a VCM conviction. Public entities, responsible for developing and maintaining this infrastructure, are constantly seeking mechanisms to guide investment decisions monetarily. One such mechanism is value capture. A value capture mechanism achieves broader public goals and private objectives through specific financial instruments. These schemes recover a portion of the benefits generated by public investments to offset their costs.

Value capture strategies operate on the principle that public investments often lead to increased valuation of private land and real estate. By "capturing" this value increase, governments can secure funds to create further community value in the future. The primary focus of research is understanding the economic impacts on nearby properties. Implementing more advanced value capture strategies alongside quantitative factors in various projects could benefit Indian cities in the future. The increase in land value surrounding public infrastructure presents significant opportunities for cities to promote development and for local authorities to recoup some of the value created using various value capture mechanisms.

The term refers to various policies and regulatory equipment designed to tap unearned increments, value uplift, or improvement in property values. The underlying premise at the back of the utility of these tools is that a proprietor or developer enjoys value increases in his/her property which can be the result of marketplace fluctuations or the movements and interventions of public bodies together with nearby government, zoning boards, and other making plans businesses. (Mualam et al., 2021)

This is an example created from parts of other articles, it is not designed to be read for sense.

In order to create commercially viable AI business models, Åström, Reim, and Parida investigate how AI providers may effectively connect value generation with value capture. A three-phase process framework that emphasises the crucial steps for value creation and capture in the development of AI business models is derived from their findings. Developing AI business model offers, matching value capture methods, and establishing prerequisites for AI value creation are some of these aspects. The authors stress that in order to assure economic success, AI suppliers need to simultaneously test and run different AI business models. This paradigm offers insights for theoretical and practical applications in the field of AI commercialization and helps to comprehend the dynamic process of innovating AI business models.(Åström et al., 2022)

The problems that Indonesian toll road concessions encounter while implementing assignment systems, such as insufficient money, inefficient operations, and poor value capture implementation. Toll road development companies suffer from reduced financial performance and construction delays as a result of these challenges. The goal of the study is to develop a conceptual framework for a business model called Road Plus Property Developers (RPPDs), which incorporates value capture techniques to improve investment performance. The researchers suggest a novel RPPD business model intended to enhance the financial results of toll road concessions using a descriptive qualitative study. In order to develop a successful business model that integrates toll road and property concession tactics and ultimately speeds up operations, the framework is meant to direct additional study.(Kurnia et al., 2024)

3.Methodology

An FAHP approach is used to classify the parameters of VCM and to identify the main parameters that are an obstacle to the implementation of VCM. Various steps such as pairwise comparison, transition from fuzzy comparison matrix (FCM) to sharp comparison matrix (CCM), and criteria weighting are carried out in the next section.

For the study, the framework is divided into two stages. In the first stage, a list of VCM parameters was identified around 28 based on an extensive literature review, whereas in the second stage, shortlisted parameters are ranked with the help of the FAHP method. Below figure shows the detailed methodology adopted for the study.

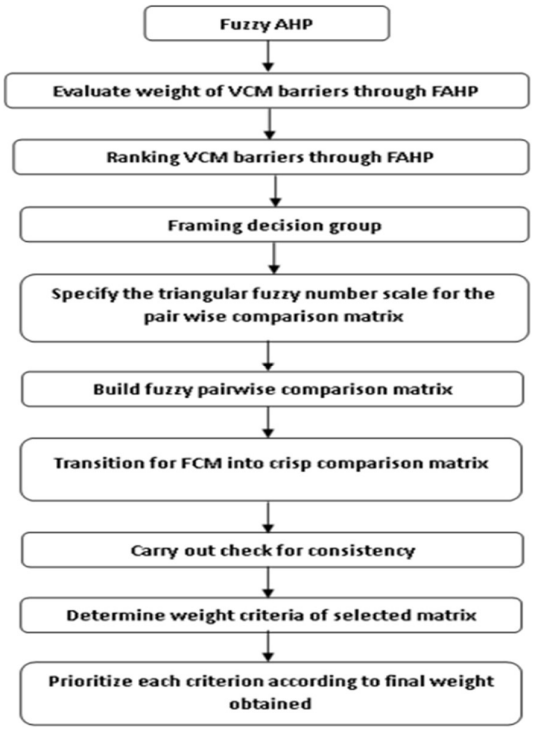

Figure 1. Methodology

In the preliminary stage, a broad review of literature is explored on the topic of VCM parameters from peerreviewed articles. The shortlisted 28 parameters by the three experts build a hierarchical structure for FAHP analysis
.

Table 1. Parameters Reported in the literature

Sr. No.	Parameters	Literature Support
1.	Lack of Co-ordination or Transparency by Authority	Hiroaki Suzuki, Jin Murakami,Yu-Hung Hong, Beth Tamayose (2015)
2.	Lack of Fiscal/Government Policy	Martim O. Smolka (2015)
3.	Lack of Government fund/Poor regional economy/Weak bond market	Urban Knowledge Asia Network (UKNA) – Shanghai Academy of Social Science (SASS) (2015)
4.	Insufficient Land banking/Financial System	Sabariah Eni, Za Mannal , Muhammad Najib Razalia (2017)
5.	Oppose New Tax/Poor Property Tax System	Self
6.	Improper Political Support	Dr. Damian Thomas, NESC (2018)
7.	Hilly Terrain	Self
8.	Lack of Resource Availability	Andreas Schroeder, Tim S Baines ,Carios Galera Zarco , Ali Zlaee Bigdeli (2016)
9.	Site Selection/Geo graphical features	Deborah Salon, AZ, Elliott Sclar (2017)
10.	Poor accessibility/Improper Road alignment	Financing Transit-Oriented Development with Land Values (2015)
11.	Poor infrastructure and services	Self
12.	Lack of PPP	M. K. LAM (2000),Sabariah Eni, Za Mannal, Muhammad Najib Razalia (2017), Oppio, Torrieri and Bianconi (2019)
13.	Slow and costly upgradation of infrastructure	Medda and Modelewska (2019)

14.	Poor operation and maintenance	Self
15.	Violation of Regulation	TatsuhitoKono, KirtiKusumJoshi (2019)
16.	Low (Govt.) Project Response	Self
17.	Poor fare box Revenue Generation	Rohit Sharma, Peter Newman (2018)
18.	Risk and return of investment from Urban project	Medda and Modelewska (2019)
19.	Poor inhabited culture	The Hague and Vienna (2005)
20.	Unbalanced between Charges and benefit system	Medda and Modelewska (2019)
21.	Risk and cost control	Value Capture Finance Policy Framework (Feb.2017)
22.	Inflation rate in property market	Sabariah Eni, Za Mannal , Muhammad Najib Razalia (2017)
23.	Risk in interest Rate	Andreas Schroeder, Tim S Baines, Carios Galera Zarco , Ali Zlaee Bigdeli (2016)
24.	Poor level of hospitality and recreational project for NRI investors	Hiroaki Suzuki, Jin Murakami,Yu-Hong (2015)
25.	Lack of upcoming project promotion	Danlele Eckert Matzembacher , Mervi Raudsaar ,Marcia Dutra de Barcellos and Tonis Mets (2020)
26.	Lack of ICT application/e-planning	Sabariah Eni, Za Mannal , Muhammad Najib Razalia (2017)
27.	E-Portal/E-dhara-poor tax savvy	Sabariah Eni, Za Mannal , Muhammad Najib Razalia (2017)
28.	Lack of Big data	Andreas Schroeder, Tim S Baines, Carios Galera Zarco , Ali Zlaee Bigdeli (2016)

In order to filter and complete the parameters of literature research and to submit to expert opinion, a committee of 12 experts is formed who have extensive field experience in the field of traffic planning, nonmotorized planning, or projects by VCM.

3.1. Ranking of VCM barriers through the FAHP method

Value Capture Mechanism (VCM) implementation barriers are ranked using the fuzzy analytical hierarchy process (FAHP) method. Fuzzy logic is combined with the concepts of traditional AHP in this method to address the subjectivity and fundamental uncertainty in pairwise comparisons. First, a thorough literature research is used to identify the VCM parameters. This is followed by expert validation.

3.2. Farming a hierarchical structure considering main and sub-criteria

To systematically analyse the VCM barriers, a hierarchical structure is developed, consisting of main and sub-criteria. An expert panel consisting of three members first identifies 28 parameters from the literature. The hierarchy helps to organise the parameters into a logical framework, and it is crucial to the FAHP analysis. Starting at the top of the hierarchy is the overarching objective of determining and prioritising VCM obstacles. To describe the particular parameters found in the literature review, each main criterion is further subdivided into sub-criteria. An in-depth and well-organized analysis is made possible by this structure.

3.3. Specify the TFN scale for the pair wise comparison matrix

Based at the hierarchical structure, a pairwise evaluation questionnaire is evolved to evaluate the principle standards and sub-standards. Pairwise comparisons are packed with a five-point Likert scale in phrases of the same importance, slight importance, excessive importance, very excessive importance, and extraordinarily excessive importance. fuzzy numbers 1,3,5,7 and 9 had been assigned respectively to every Likert scale matrix to be transformed right into a fuzzy compression matrix (FCM). Below Table indicates the Likert scale, the fuzzy number, and the club feature respectively, even as below Figure indicates the schematic view of the bushy club feature assigned to every Likert scale and their club feature.

Table 2. Scale of Relative Importance

Likert scale	Fuzzy Number Allotted	Membership Function (l, m, u)
Equal Importance	1	(1,1,3)
Moderate importance	3	(1,3,5)
Strong Importance	5	(3,5,7)
Very Strong Importance	7	(5,7,9)
Extremely strong Importance	9	(7,9,11)

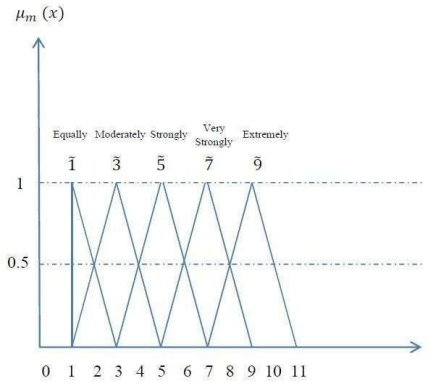

Figure 2. Fuzzy Membership Function

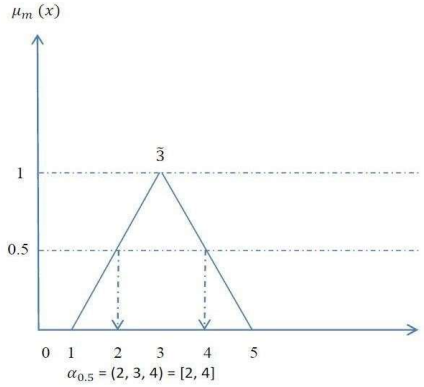

Figure 3. α-Cut Value

3.4. Build the Fuzzy Pairwise Comparison Matrix (FCM)

After finalizing the questionnaire, the professional institution is invited to carry out a pairwise evaluation of the principle standards and sub-standards of the usage of a fuzzy number. The paired evaluation questionnaire includes a complete of seven matrices which include one matrix for the principle standards and the closing six matrices for 28 sub-standards. The consolidated matrix for the pairwise evaluation of the principle standards is provided in the below table.

Table 3. Pairwise Comparison of Main Criteria

Attributes	AB	GB	IB	SB	BB	TB
AB	1	3	3	5	7	3
GB	1/3	1	1	3	5	3
IB	1/3	1	1	3	7	5
SB	1/5	1/3	1/3	1	3	3
BB	1/7	1/5	1/7	1/3	1	1
TB	1/3	1/3	1/5	1/3	1	1

3.5. Transition of FCM into Crisp Comparison Matrix (CCM)

After completing FCM it is required to convert matrix in to Crisp Comparison Matrix (CCM) the usage of αcut manner. The α-cut manner basically tries to simply accept as authentic with professionals or choice maker on their choice or choice. In the present study, value for α is taken as 0. 5 which means that in the process of pairwise contrast matrix selection institution panel has a mild assure for their choice. An allotment of the decrease limit (l) and higher limit (u) of fuzzy numbers with inside the process of α- reduce are completed the usage of equation (1). Figure represents the α-reduce operation for triangulation fuzzy number (TFN). By putting the fee of α within side the given equation (1) the FCM ($\tilde{\chi}$) is transformed into αreduce crisp comparison matrix ($\tilde{\chi}a$). The transformed α-reduce crisp comparison matrix ($\tilde{\chi}a$) for most important requirements is validated below:

$$\forall[0,1]\widetilde{M}_{\alpha} = [l^{\propto}, u^{\propto}] = [(m-l) \propto +l, -(u-m) \propto +u] \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\tilde{x}^{a} = \begin{pmatrix} 1 & 2,4 & 2,4 & 4,6 & 6,8 & 2,4 \\ \frac{1}{4},\frac{1}{2} & 1 & 1 & 2,4 & 4,6 & 2,4 \\ \frac{1}{4},\frac{1}{2} & 1 & 1 & 2,4 & 6,8 & 4,6 \\ \frac{1}{6},\frac{1}{4} & \frac{1}{4},\frac{1}{2} & \frac{1}{4},\frac{1}{2} & 1 & 2,4 & 2,4 \\ \frac{1}{8},\frac{1}{6} & \frac{1}{6},\frac{1}{4} & \frac{1}{8},\frac{1}{6} & \frac{1}{4},\frac{1}{2} & 1 & 1 \\ \frac{1}{4},\frac{1}{2} & \frac{1}{4},\frac{1}{2} & \frac{1}{6},\frac{1}{4} & \frac{1}{4},\frac{1}{2} & 1 & 1 \end{pmatrix}$$

To convert α-cut crisp comparison matrix further into CCM, the value of degree of optimism (μ) is taken as 0.5. Hence by replacing the value of μ in equation (2) of α-cut comparison matrix ($\tilde{x}^{a}$) is converted to CCM (X).

$$\tilde{x}_{ij}^{a} = \mu\tilde{x}_{ijl}^{\propto} + (1-\mu)\tilde{x}_{iju}^{\propto} \ldots\ldots\ldots\ldots\ldots\ldots (2) \qquad \text{where } 0 \le \mu \le 1$$

$$X = \begin{pmatrix} 1 & 3 & 3 & 5 & 7 & 3 \\ 0.375 & 1 & 1 & 3 & 5 & 3 \\ 0.375 & 1 & 1 & 3 & 7 & 5 \\ 0.2084 & 0.375 & 0.375 & 1 & 3 & 3 \\ 0.1458 & 0.2084 & 0.1458 & 0.375 & 1 & 1 \\ 0.375 & 0.375 & 0.2084 & 0.375 & 1 & 1 \end{pmatrix}$$

3.6. Carry Out the Check for Consistency

To test the consistency with the opinion of every professional a consistency takes a look at is providers. For that Eigen values for CCM (X) of the main criteria are calculated as below:
From the above-obtained eigenvalues, it is observed that $\lambda_{max} = \lambda_1 = 6.561711$ Therefore, the consistency index (CI):

$$CI = \frac{\lambda_{max} - n}{n-1}$$

$$CI = \frac{(6.562711 - 6)}{6-1}$$

= 0.112342

Table 4. Random Consistency Index

Size of Matrix(n)	1	2	3	4	5	6	7	8
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.40

Corresponding to the matrix size n=6, the value of RI is taken as 1.25 from the above Table.

$$CR = \frac{CI}{RI} = 0.112342 / 1.25 = 0.1011 \le 0.1 \text{ (condition satisfied)}$$

According to (Yadav, Seth and Desai, 2018), all of the comparison matrix of main and sub criteria must fulfil situation of CR ≤ 0.1 (Yadav, Seth and Desai, 2018). If the situation isn't pleased, then specialists are asked to edit their wrong judgments in contrast matrix until the CR ≤ 0.1 situations now no longer fulfil.
The above point out method is accompanied for take a look at the consistency for all matrix of primary and all sub standards. In the have a look at the price of CR for all calculated matrix are satisfied with the situation for this reason all comparison matrix is acceptable.

3.7. Determine Weight Criteria of the Selected Matrix

After satisfying and acquiring the CR values for all of the comparison matrixes the subsequent step is to decide the weight of the matrix. For that a three-step method to calculate the weights of main criteria and sub criteria is described below.

a) The column sum of each CCM is calculated.

[2.4792, 5.9582, 5.7292, 12.725,24,16]

b) Respective values of CCM will be divided by sum of each column.

$$X = \begin{pmatrix} 0.4034 & 0.5035 & 0.5236 & 0.3929 & 0.2920 & 0.1875 \\ 0.1513 & 0.1678 & 0.1745 & 0.2358 & 0.208 & 0.1875 \\ 0.1513 & 0.1678 & 0.1745 & 0.2358 & 0.2920 & 0.3125 \\ 0.0841 & 0.0625 & 0.0655 & 0.0786 & 0.125 & 0.1875 \\ 0.5880 & 0.0349 & 0.0254 & 0.0295 & 0.0416 & 0.0625 \\ 0.1513 & 0.0629 & 0.0364 & 0.0295 & 0.0416 & 0.0625 \end{pmatrix}$$

c) Compute the row sum for every row of the matrix and divide every row sum with the aid of using the order of matrix.

$$X = \begin{pmatrix} \textbf{Weight} & \textbf{\textit{Main Criteria}} & \textbf{\textit{Rank}} \\ 0.3838 & \textit{Administration barriers} & 1 \\ 0.1875 & \textit{Geographical barriers} & 3 \\ 0.2223 & \textit{Infrastructure barriers} & 2 \\ 0.0819 & \textit{Social barriers} & 5 \\ 0.1303 & \textit{Business barriers} & 4 \\ 0.0640 & \textit{Technological barriers} & 6 \end{pmatrix}$$

3.8. Prioritize Each Criterion According to Final Weight Obtained

Finally, the global weights of all criteria are acquired through multiplying the weight of the main criteria to the corresponding weight of sub-standards.

Table 5. Final Prioritization of VCM Barriers

Main Criteria	Main Criteria Weight	Sub Criteria	Sub criteria weight	Global Weight	Rank
Administration Barriers	0.3838	Lack of Co-ordination or Transparency by Authority	0.17305	0.066	7
		Lack of Fiscal/Government Policy	0.358	0.1374	1
		Lack of Government fund/Poor regional economy/Weak bond market	0.2856	0.1096	2
		Insufficient Land banking/Financial System	0.0902	0.0346	11
		Oppose New Tax/Poor Property Tax System	0.0456	0.0175	19
		Improper Political Support	0.1146	0.0439	8
Geographical Barriers	0.1875	Hilly Terrain	0.4735	0.0887	3
		Lack of Resource Availability	0.4735	0.0887	4
		Site Selection/Geographical features	0.0531	0.0099	22
Infrastructure Barriers	0.2223	Poor accessibility/Improper Road alignment	0.3827	0.0851	5
		Poor infrastructure and services	0.3457	0.07684	6
		Lack of PPP	0.1083	0.0240	16
		Slow and costly upgradation of infrastructure	0.0579	0.0128	21
		Poor operation and maintenance	0.1048	0.0232	17
Social Barriers	0.0819	Violation of Regulation	0.3958	0.03241	13
		Low (Govt.) Project Response	0.3198	0.02619	15
		Poor fare box Revenue Generation	0.0652	0.00533	26
		Risk and return of investment from Urban project	0.1177	0.00096	28
		Poor inhabited culture	0.1012	0.00828	23
Business Barriers	0.1303	Unbalanced between Charges and benefit system	0.31275	0.0407	10
		Risk and cost control	0.2499	0.0325	12
		Inflation rate in property market	0.20675	0.02693	14
		Risk in interest Rate	0.1076	0.01402	20
		Poor level of hospitality and recreational project for NRI investors	0.0619	0.00806	24
		Lack of upcoming project promotion	0.0534	0.00695	25
Technological Barriers	0.0640	Lack of ICT application/e-planning	0.6417	0.0410	9
		E-Portal/E-dhara-poor tax savvy	0.3016	0.0193	18
		Lack of Big data	0.0566	0.00362	27

4. Conclusion

Global and local Weightage of each individual parameters with respect to revenue generation is studied using FAHP approach. It is found that, administrative parameters, infrastructure parameters, geographical parameters, business parameters have criteria weights 0.38, 0.22, 0.19, 0.13 respectively.

In conclusion, this paper provides valuable insights into the qualitative approach for understanding value capture mechanisms in the context of the Indian urban project. By examining the challenges and opportunities associated with value capture parameters prioritisation, this research contributes to the body of knowledge on effective strategies for financing urban development projects by adopting parameters which will act as a carrier to capture value and make urban project self-sealing in terms of financial aspects.

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