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Factors affecting land value of urban voids in western part of India

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Abstract

Urban voids are the key determining factors to utilize efficient manner for sustainable development. These areas need to be understood through their land potentials. Land valuation determines the value of urban voids based solely on their natural characteristics. The research papers present a papered examination of land value modeling and its influencing factors. The study concentrates on Jaipur, the capital city of Rajasthan, selected as the research area. The land value modeling process consists of three stages. Initially, various approaches and issues have been identified for land valuation. In the second stage, factors have been identified for land valuation. Lastly, land valuation methods such as the ordinary least squares (OLS) regression have been used. The primary factors influencing land value in the research area include distance to major highways, proximity to schools, railway lines, specific communities, availability of infrastructure, etc. Interestingly, variables such as slum area, landfill, rail line, and proximity to specific communities exhibit an inverse relationship. This research provides valuable insights into the localized variations in land prices within an Indian city.

Keywords: Urban voids, Land value, Ordinary least squares, Geographic information system, JMP, SPSS model, Jaipur

Introduction

Land is considered an indispensable natural asset that holds paramount significance for all facets of developmental undertakings, particularly in urban settings. The issue of land scarcity pervades the densely woven urban fabric of the global landscape. The situation becomes worse when available land remains underutilized for assorted reasons, giving rise to what we term "urban voids." These voids are found in diverse forms such as abandoned structures, vacant parcels, deteriorating infrastructure, residual spaces amidst buildings, and areas beneath elevated roadways (R.O.B.), among others. Urban voids represent unoccupied or underexploited areas within a city that lack a defined purpose and are often perceived as neglected due to numerous factors. Ensuring the judicious use of this finite resource is a paramount concern for all stakeholders. Inadequate land utilization can potentially lead to catastrophic consequences within urban areas. The land possesses multifaceted attributes, encompassing physical, social, economic, and environmental dimensions while the economic aspect plays a pivotal role in contributing to the overall advancement of urban areas [1].

An extensive study of the literature suggests the significance of land valuation for a range of stakeholders, including local governments, brokers, valuers, planners, money lenders, bankers, and politicians [2]. Developed nations have established robust data sources to accurately assess land valuations. Consequently, the real estate sector in developed countries has made substantial contributions to the state's economy through transaction charges and property taxes [2]. However, numerous studies have acknowledged the challenges associated with real estate valuation in developing nations. These challenges become evident from the scarcity and unreliability of data, as mentioned by Armiah's 1992 study on sub-Saharan Africa [3] and Sharma and Newman's 2018 research on the land value of Bangalore, India [4]. In developing countries, income generated from property assets lags that of developed countries due to the unavailability and unreliability of transaction data [5]. The most important aspect is that India's real estate market distinguishes itself from both developed nations and other developing counterparts by virtue of its unique social and economic backdrop. The value of urban land in Indian cities has witnessed exponential growth, propelled by commercial opportunities, and accompanying amenities [6]. Notably, the migration to urban areas in India significantly influences housing density and property prices [5]. Major cities that have been found with substantial migrant influx, such as Mumbai and Delhi, have witnessed a remarkable upsurge in property prices over the past few decades [5]. On the other hand, various forms of urban voids persist, adversely impacting overall development. These urban voids, particularly in developing countries, where resource constraints and the neglect of certain areas are prevalent, can become the potential with numerous benefits [7].

Recognizing the potential contributions of these vacant spaces to a city's social, economic, and environmental dimensions is crucial for effective urban planning and development. It is important to note that there is a shortage of published research on real estate-related aspects within the Indian context, due to the lack of relevant data availability.

Research problem

Most studies conducted in the Indian subcontinent have focused on a macro-level context [5]. To gain a comprehensive understanding of the spatial distribution and factors influencing land values within urban voids in a specific geographic region, there is a need for studies conducted at the micro level. Also, no studies have been identified that specifically address the critical zones within the western part of Indian cities. In accordance with various urban planning policies, urban areas should ideally develop in a harmonious and uniform manner.

This study aims to bridge these gaps by identifying various urban voids, gathering data on their land valuations, and analyzing the factors that influence land values. The findings from this research can contribute to the identification of critical zones within Jaipur city, potentially leading to the refinement of urban policies [8, 9]. This study not only addresses the research gap but also expands the scope of land valuation studies in a data-deficient market like India by conducting a micro-level land valuation study of urban voids in a tier-2 Indian city.

Research objective

The objective of this research is to identify key factors influencing land valuation in the context of urban voids within Jaipur city, Rajasthan. This endeavor aims to provide valuable insights for policymakers, development authorities, and various stakeholders, enabling them to conduct a detailed analysis at the micro-level of urban voids and their potential for sustainable development. Such insights can inform the refinement of policies, urban planning strategies, and financial mechanisms, including transaction charges and property taxes within the area. By pinpointing critical zones, these entities can formulate infrastructure proposals to each zone, fostering a more uniform and sustainable development approach. Furthermore, this research sets the stage for future investigations, offering a framework for utilizing urban voids in alignment with the aspirations of the local population. It facilitates the development of planning and financial frameworks to advance Sustainable Development Goals.

This research serves as a base work for identifying varied factors that impact land valuation, with potential applicability in different regions worldwide. In contrast to the traditional comparable method commonly used for land valuation in Jaipur, this study employs advanced modeling techniques that leverage transaction data and land attributes to establish statistical models. This approach is expected to yield a deeper understanding of the property market dynamics [10]. The study's methodology involves the development of a model to analyze urban land values in Jaipur, the capital city of Rajasthan, India. This model integrates property values with socioeconomic data, survey information, and geospatial data using Geographic Information Systems (GIS). The resultant model will highlight specific characteristics of the property market in urban Rajasthan.

Research methodology

Figure 1 shows the research methodology.

Literature review

The review is divided into three parts: Part one briefly summarizes various approaches used in land valuation. Part two summarizes the factors affecting land valuation. Finally, part three describes land valuation methods used in various research papers.

Approaches and issues

The land valuation approaches and issues have been identified by various authors in different timelines and in different countries and regions. Different authors have identified various approaches and issues for land valuations such as the land valuation data in developing countries are not reliable to get strong results so other techniques such as E-portal and survey need to be part of data collection [3, 4]; other papers suggest that detailed research related to land value is missing in Indian subcontinents. It should be based on geographical location, so it is required to see land valuation in a micro context [5, 11]; there is a comparison of the land market between developing and developed nations and socio-economic parameters play a key role in defining the land market in developing nations [6]. Other research paper suggests that

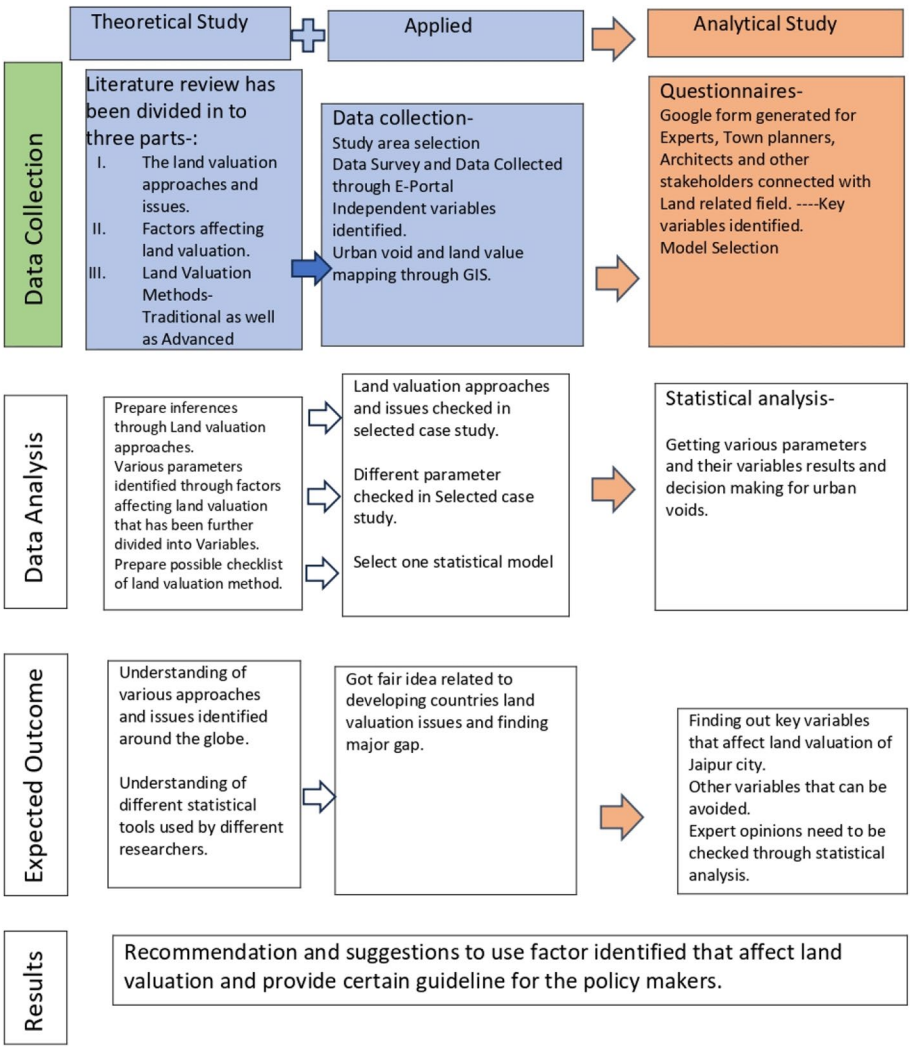

Fig. 1 Research methodology (ref: authors)

the land value increment cannot be checked in India because reliable data are not available and translation of property is quite different in developing nations and the actual value cannot be determined by the registered value in the revenue department, so survey data is more reliable than published data [5, 12]. There is a research gap related to land valuation of vacant land [13]. Other researchers suggest that the published data related to land valuation is very little because reliable data is not available, so it is needed to find other sources for land value data collection [14]. From the above studies, it is clearly stated that land valuation is a complex matter and still it has not been worked upon judiciously as well as land valuation data cannot be taken from published data.

Factors affecting land values

The study is required to see land valuation in a micro context so that numerous factors can be identified and relationships can be established. Authors of different timelines and regions

have identified numerous factors that can affect property values. These factors are regional-specific, but they give us clues to critically evaluate through quantifiable techniques.

Some of the factors suggested by authors such as location and accessibility factors affect land valuation [15]. Infrastructure facilities are the determining factor for land valuation [16]. Zoning and height regulation determine the land price [17]. Transportation costs play a key role in land valuation [18]. Property attributes, geographic location, and facilities play a key role in land valuation [19]. Proximity to CBD and transportation network play a key role in land valuation [20]. Accessibility to transit developments and land location is the main cause of the rise in land value [21, 22]. Socio-economic and neighborhood characteristics affect land prices [17]. Accessibility, physical attributes, regulations, and socio-economic conditions affect land prices [23]. Numerous factors have been identified in different timelines and regions. Some of the factors have loosened up due to fast-changing technological interventions, changes in the socio-economic fabric, and other factors. These factors can be utilized as variables that may affect the land valuation of the area.

Land valuation methods

Various research papers suggest that land valuation methods have been used at different times and in different parts of the world; for instance, one of the research papers suggests that the traditional method can be used for land valuation [24] (Fig. 2). Different hedonic approaches are used as statistical models to calculate land prices [25]. Advanced modeling methods are now adopted in land valuation techniques [26]. The study suggests that O.L.S. is used to calculate land value in different geographical locations [19]. Spatial error model has been used to calculate land prices [27]. Remote sensing and GIS should be used for data generation and preparation of models [28]. From these studies, it is evident that land valuation is a complex task; it requires a strong relationship between different variables. Advanced land valuation methods such as the spatial regression model, ordinary least square methods, and hedonic price models have been used to identify numerous factors involved in ascertaining land value. These quantifiable methods can be used in different study areas. Advanced land valuation method has been utilized in Thiruvananthapuram, Kerala, a southern part of India city—3rd Tier city [14]. A similar method can be used in other parts of Indian cities. These variables have been tested in the western part of India and other research papers can target different regions of the eastern and northern parts of India.

Study area

Jaipur has been chosen as the study area and divided into various wards. It is well connected with all metro cities. It is a tier-1 city with a population of 4,107,000 (about twice the population of New Mexico) (about twice the population of New Mexico) population of which 3,471,847 (52.40%) live in the urban region of the district (Census 2022). Investment in properties is considered a very lucrative option for investments. Jaipur residential colonies were set up by housing societies in the initial stages, these colonies were not well

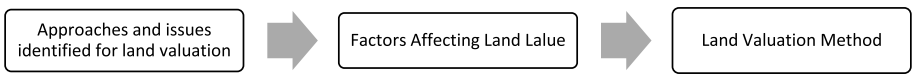

Fig. 2 Land valuation process (ref. authors)

planned, so we find lots of deficiencies in terms of facilities, width of roads, schools, and other infrastructure facilities. On one side, we find lots of deficiencies and on the other side lots of urban voids are visible due to assorted reasons; this type of leapfrog development is not sustainable development. This research paper is an attempt to find urban voids and check the economic potential of chunks of land in different parts of the cities. The Jaipur Master Plan 2025 indicates that approximately 50% of the city is designated for residential use. Other zones, including commercial, institutional, and recreational areas, are distributed across various parts of Jaipur. Various industrial sectors are in different areas throughout the city. The CBD area, established in 1727, represents the walled city of Jaipur. Various multi-nodal hubs of commercial establishments are evident across various parts of the city. The predominant commercial land use aligns linearly along major highways and roads, as outlined in the Jaipur Master Plan 2025. Different industrial setups have been established in various parts of the city in different timelines. Labor housing has been established around industrial setup. Migration inflow can be seen, and it has affected the housing density in various parts of Jaipur city. Socio-economic variations are also visible. Different communities such as Hindu, Muslim, Sikh, and Christian communities are living with different occupations and economic standards. Lots of labor colonies are visible around the industrial area. Some of the restricted zones such as Military areas, UNESCO-protected areas, and ecological sensitivity areas also existed. The walled city of Jaipur has been designated as a UNESCO-protected city (Fig. 3).

Methods

Aim

The aim of the research paper is to investigate the viability of numerous factors/parameters that can affect urban void land valuation. Additionally, the study will determine whether these factors significantly contribute to any specific piece of land or if their contributions vary across different cities, regions, or countries.

Design and setting of study

Data collection

Numerous factors identified through the literature review affect land value for Jaipur city (Fig. 4). Different questionnaires have been floated to different stakeholders associated

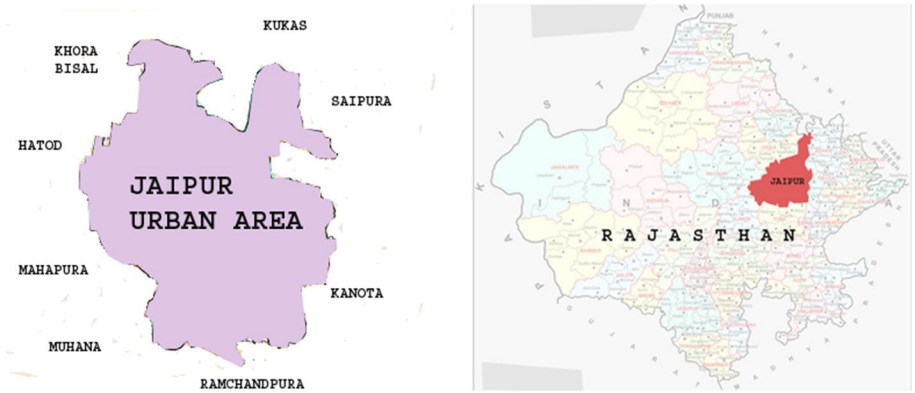

Fig. 3 Study area map (ref: mapdata@2024)

with real estate, construction, and planning in different government and private organizations (Fig. 5). Various experts' and officials' opinions were taken through Google form.

Around 48 responses were received from government and private organizations and the results are shown in Figs. 6, 7, 8, 9, and 10.

Expert opinion suggests that factors such as the distance to the national highway/state highway, major district roads, and proximity to rail terminals (considered accessibility factors); proximity to the central business district (CBD), major employment hubs, the quantity of commercial buildings, and proximity to schools and hospitals (proximity factors); closeness to garden areas, slum areas, landfills, and industrial zones (environmental factors); proximity to specific communities and housing density (socio-economic factors); and availability of water supply, land in planned development, and land use (plot

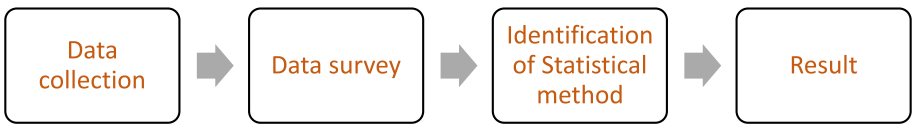

Fig. 4 Land valuation methods

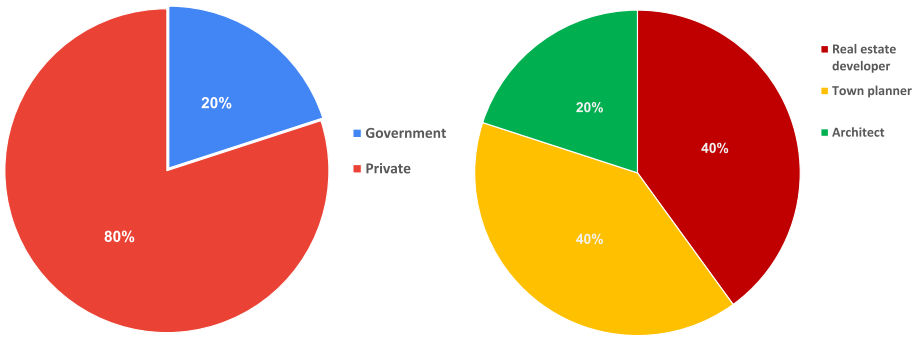

Fig. 5 Selection of stakeholders for Survey data (ref: authors)

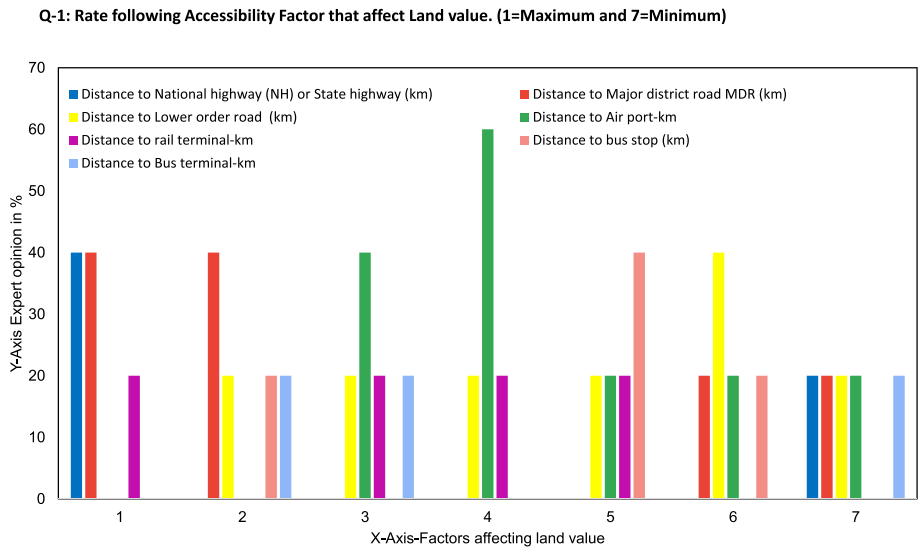

Fig. 6 Accessibility factor affecting land value (ref: authors)

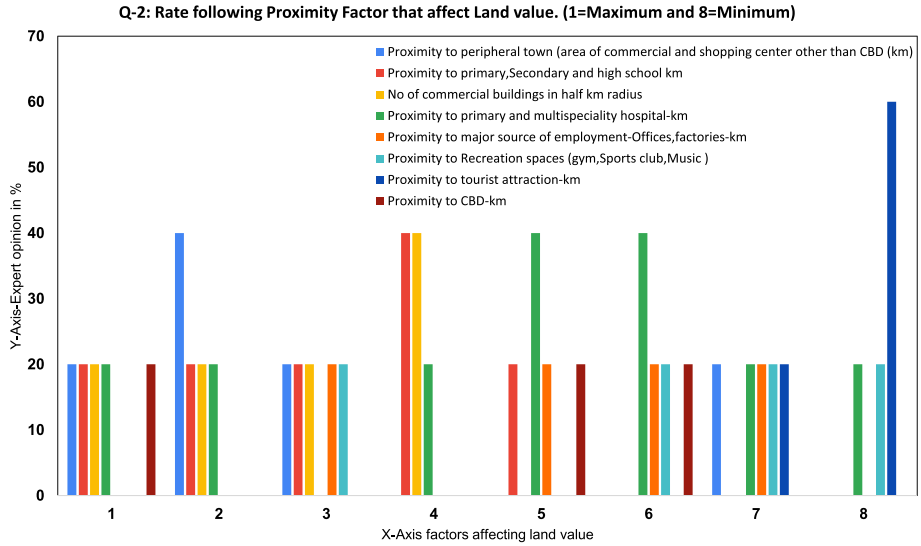

Fig. 7 Proximity factor affecting land value (ref: authors)

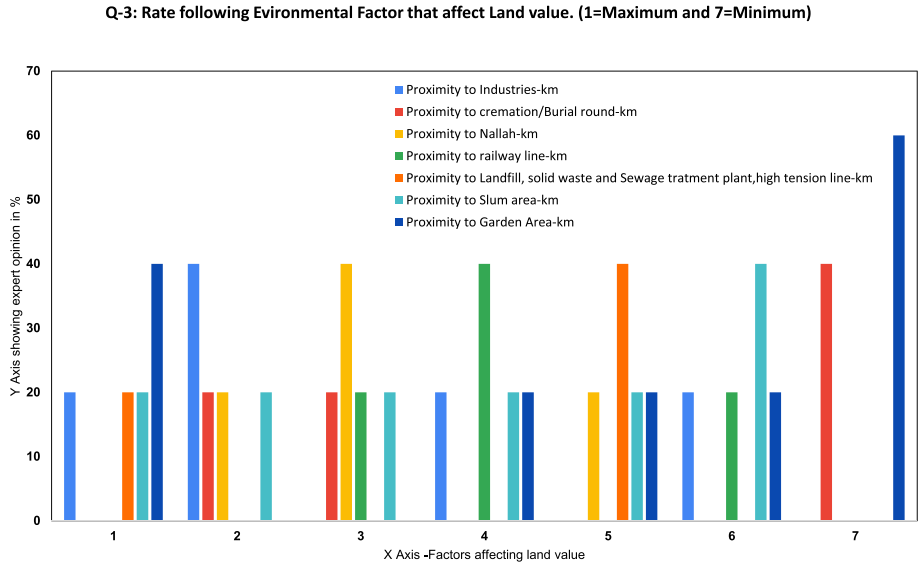

Fig. 8 Environmental factor affecting land value (ref: authors)

attributes) significantly influence land value, followed by the distance to lower roads and bus terminals (accessibility parameters), proximity to nallah and proximity to cremation area (Environmental factor), proximity to lower income area (socio-economic factors), and plot in a restricted zone and availability of sewage network (plot attributes). Other factors have a comparatively lesser effect on land value.

Data survey

One hundred urban void locations were identified and marked on a map through a physical survey (Fig. 11), and data were collected for land value and other explanatory variables. Euclidean distance was used to calculate distances [18, 29–31]

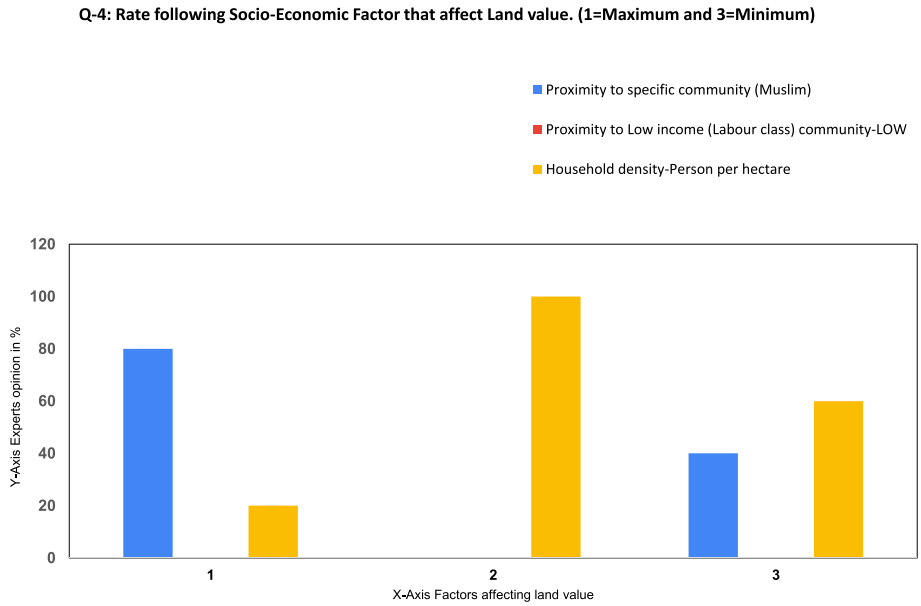

Fig. 9 Socio-economic factor affecting land value (ref: authors)

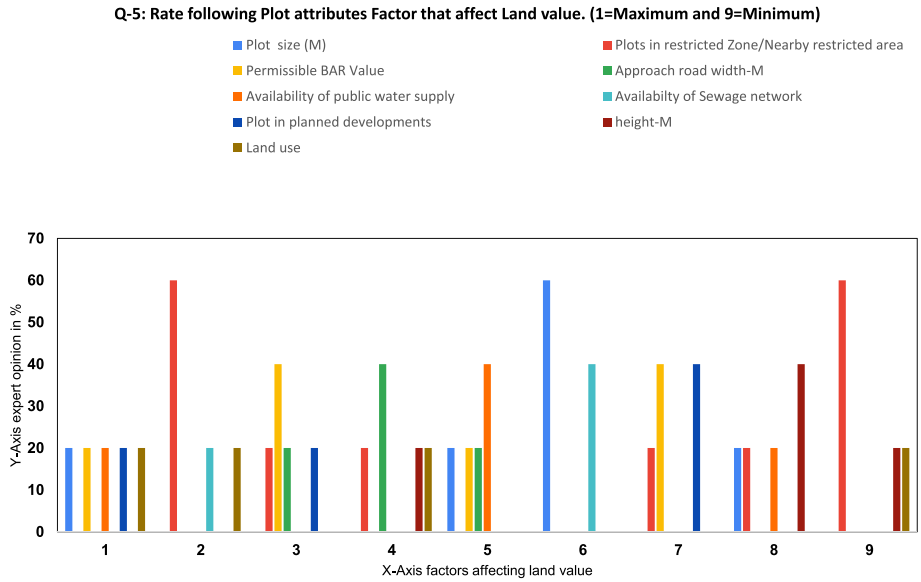

Fig. 10 Plot attributes factor affecting land value (ref: authors)

Jaipur city does not have reliable land record data. The primary reason is that registry charges are extremely high and the DLC rate from which land transaction occurs is exceptionally low as compared to actual land transaction. Therefore, land value data for this study was collected from e-advertisements through portal 99acres (about half the total floor space of the Pentagon) from Jan 2021 to Feb 2023. 99acres (about half the total floor space of the Pentagon) is the most used online property search portal in Jaipur city, so its data has been collected. Several studies have used advertisement prices due to the non-availability of data and have reported significant results

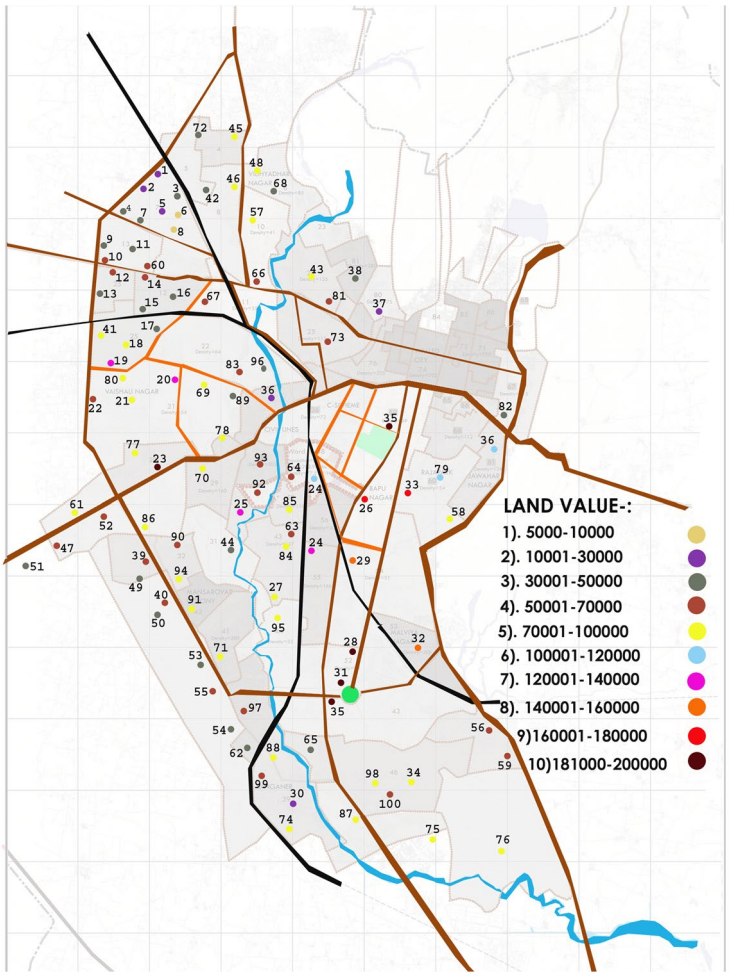

Fig. 11 Urban void location on Jaipur master plan with ward boundaries (ref: authors) (source: Google Earth Pro and GeoDa software)

[32–36]. The final 100 locations were selected, and a physical survey was done to check the viability of online data through discussion with property agents.

The higher values were seen in major landmarks such as Jawahar Circle and central park and on the edge of major roads.

The mean value of land in Jaipur is 70,161 rupees per square meter, with values ranging from 8000 rupees to 200,000 rupees (Table 1).

The study utilized 100 variables as represented in Table 1. The data for these variables were generated through Google Earth Pro map and field survey. The explanatory variables were classified into five categories: accessibility, proximity, environmental, socio-economic, and plot attribute variables [14].

Accessibility parameters Seven variables under this category were chosen through literature review and expert opinion. Variables were measured as Euclidean distance. The variables in this category represent various proximity measures such as distance to highways, MDR, lower road, bus terminal, rail terminal, airport, and bus stop (Table 1) [37].

Table 1 Variables details [12]

S. No	Variable name	Description	Minimum	Maximum	Mean	SD
LV		Land value per square meter	8000	200,000	70,161	39,494
Accessibility parameters						
1	NH/SH-Dis.	Distance to national highway (NH)/state highway (SH) km	.01	1.9	.4168	.3978
2	MDR-Dis	Distance to major district roads (MDR) (km)	0.000	1.8	0.1736	0.2506
3	ODR-DIS.	Distance to lower order roads (except NH, SH, and MDR) km	0.000	2.0	0.199	0.3282
4	Airport-Dis	Distance to airport (km)	0.5	12.89	6.4057	2.9457
5	Rail T.-Dis	Distance to rail terminal (km)	0.92	10.12	4.9052	2.0787
6	Bus T.-Dis	Distance to bus terminal (km)	0.35	11.8	4.9434	2.6302
7	Bus S-Dis	Distance to bus stops (km)	0.000	1.2	0.19238	0.2778
Proximity parameters						
8	CBD-Dis	Distance to CBD (central business district) (km)	0.5	12	5.9609	3.0278
9	Per T-Dis	Distance to peripheral towns (areas of commercial and shopping centers other than CBD) (km)	0.002	5.803	1.4636	1.2085
10	Com-N	Number of commercial buildings in a half-kilometer radius	8	200	63.76	35.566
11	Sch-Dis	Distance to primary, secondary, and high schools (km)	0.000	3.6	1.43008	0.9548
12	Hosp-Dis	Distance to primary and multispecialty hospitals (km)	0.38	11.5	3.2740	1.6252
13	Employ-Dis	Distance to major sources of employment (IT parks, factories, offices, etc.) (km)	0.48	10.98	6.1129	2.1452
14	Recre-Dis	Distance to recreation area (gym/club) (km)	0.4	8.4	3.69966	1.6569
15	Tour-Dis	Distance to tourist attractions (km)	0.2	9.7	4.144	2.5281
Environmental parameters						
16	Polin-Dis.	Proximity to polluting industries (km)	0.5	17.5	6.73497	2.7983
17	Crem-Dis	Proximity to crematoriums and graveyards (km)	0.001	3.8	1.0381	0.8489
18	Nallah-Dis	Proximity to Amani shah Nallah (km)	0.01	2.9	0.7873	0.6308
19	Rail L-Dis	Proximity to rail line (km)	0.2	6.932	3.0022	1.2536
20	LandF-Dis	Proximity to landfill area (km)	0.09	3.7	1.74891	1.0028
21	Slum-Dis	Proximity to illegal settlements/ slums (km)	0.04	8	3.16564	1.6417
22	Gar-Dis	Proximity to garden area (km)	0.001	2.2	0.1746	0.3329
Socio-economic parameters						
23	Speci C-Dis.	Proximity to specific religious/cast-based communities (km)	0.02	7	3.3326	1.6908
24	H-Low	Quality of neighborhood housing: low (labor housing)	0.000	5.18	2.19510	1.3546
25	H-M	Quality of neighborhood housing: medium	0	2.2	0.77909	0.6076
26	H-High	Quality of neighborhood housing: high	0.01	3.6	1.13325	0.7990
27	Rest-Dis	Distance to restricted/regulated zones (military area, bypass, walled city, etc.) (km)	0.02	4.95	1.9389	1.1929
Plot attribute parameters						
28	Appr. R-W	Approach road width (m)	7.5	60	28.465	13.533
29	Water S-Ava	Availability of public water supply (Yes: 1, No: 0)	0	1	0.88	0.3265
30	Sewage-Ava	Availability of sewage network (Yes: 1, No: 0)	0	1	0.82	0.3861
31	Planned-P	Plots available in planned development (Yes: 1, No: 0)	0	1	0.77	0.4229
32	Height-P	Permitted height as per prevailing building bye-laws	0.001	0.06	0.0212	0.0093

Proximity parameters Eight variables under this category were chosen through literature review and expert opinion. Except for the no. of commercial buildings within 1-km distance, all other variables were measured as Euclidean distance. The variables in this category represent various proximity measures such as distance to CBD, peripheral towns, hospitals, schools, tourist places, employment sources, recreation area, and no. of commercial buildings (Table 1).

Environmental parameters Seven variables under this category were chosen through literature review and expert opinion. Variables were measured as Euclidean distance. The variables in this category represent proximities to industries, cremation, nallah, railway line, landfill, slum area, and garden area. Expect proximity to a garden area and other proximities have adversely affected land value (Table 1).

Socio-economic parameters Three variables represent proximity to a specific religious/cast community in the study area. Jaipur has specific communities in various parts of the city, and it has been added through expert interventions. Housing quality has been taken as a key detriment in comparison to housing density. Proximity to low-income groups has also been taken as there are lots of labor housing near industrial areas (Table 1).

Plot attribute parameters Nine variables have been used. The permissible FAR value, distance to regulated zones, permissible height, approach road width, planned development, plot size, available water and sewage network, and land use are the variables from this category. Jaipur lies in Zone-2 of the disaster map of India, so it is comparatively safe as well as it is a dry city, so disaster and water logging variable have not been considered [38, 39].

Identification of statistical method

An ordinary least square (OLS) regression model has been used to test the land valuation through statistical methods. Urban voids have been marked in various locations on the Jaipur map and all the points have been geo-referenced Google Earth Pro and Euclidian distance has been marked to get the actual distance of different parameters to the point (Urban void) [37]. Standard error, adjusted R^2, and VIF factors have been analyzed through JMP and SPSS model [40–42].

Model methodology

Figure 12 shows the modeling methodology.

A total of 100 samples of urban voids have been taken in various parts of Jaipur city. To check the multicollinearity effects, variance impact factor (VIF) has been analyzed through SPSS and JMP models (Table 2). The VIF has been found below 10 so multicollinearity impact has not been found in the data set. There is no sharp dip between R^2 and adjusted R^2 in the OLS model (1%); also, Prob>$|t|$ is 0.406 so the model is quite significant to use and analyze (Table 3) [45–47].

Now to further check that each factor is important in determining land values in Jaipur city, a further analysis of the variables was done through the application of

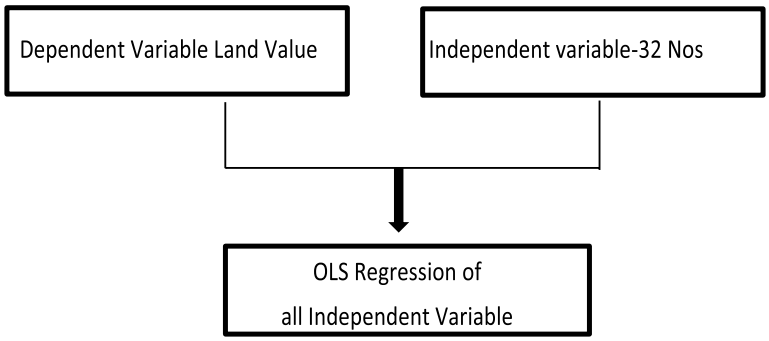

Fig. 12 Modeling methodology [14, 43, 44,]

principal component analysis and rotation loading that are equal or greater than 0.50 are considered high and acceptable.

The MSA value for proximity to bus stops, bus terminals, and middle-income groups has been found below 0.5 so that factor cannot be taken for analysis (Fig. 13). The Proximity to industries, availability of water supply and sewage network, and permissible building height has negative coefficient so it is not possible, so this factor be removed and distance from higher income group has positive impact that is also not practical so this factor has been removed to remove all these factors, we can get following results

The VIF has been found below 10 so multicollinearity impact has not been found in the data set (Table 4). There is no sharp dip between R^2 and adjusted R^2 in the OLS model (1%); also, Prob>|t| is 0.767 so the model is quite significant to use and analyze (Table 5).

Multiple regression analysis: This was undertaken to determine the significant contributions of the 24 factors out of 32 in influencing land values in Jaipur city (Fig. 14).

$Y = \mathrm{B0} + \mathrm{B1f1} + \mathrm{B2f2} + \mathrm{B3f3} + \ldots + \mathrm{B24f24} + \mathrm{E}$

$Y =$ value of land as rated by 24 factors.

$E =$ error

The estimated coefficients and their p-values are presented in Table 6—contribution of factors to land values.

Based on their p-values, varied factors have been ranked. By the ranking, factor 6 contributed more followed by factors 21, 20, 23, 11, 02, 17, 22, 08, and 14 in that order. Other factors have also contributed based on their rankings.

The result of the multiple regression analysis provides the measure for ranking the 24 factors influencing land values in the study areas based on the magnitude of their contribution.

Results and discussion

The stakeholder survey data (Fig. 5) underscores the considerable impact of various independent variables on the land value of urban voids. These variables were assessed using statistical tools across 100 surveyed urban voids in different parts of the study area, revealing the following comparisons or analyses.

Table 2 OLS regression coefficients through SPSS model

Variable name	Coefficient	SE	VIF
Constant	1.201	1.437	
Accessibility parameters			
NH/SH-Dis.	−0.004	0.380	4.268
MDR-Dis	2.598	0.850	8.483
ODR-DIS.	−0.242	0.617	7.655
Airport-Dis	0.025	0.043	3.007
Rail T.-Dis	−0.074	0.047	1.799
Bus T.-Dis	0.052	0.035	1.554
Bus S-Dis	0.559	0.346	1.724
Proximity parameters			
CBD-Dis	0.075	0.073	9.184
Per T-Dis	−0.084	0.101	2.756
Com-N	0.013	0.006	9.953
Sch-Dis	0.105	0.127	2.743
Hosp-Dis	0.057	0.071	2.470
Employ-Dis	−0.203	0.062	3.327
Recre-Dis	−0.095	0.067	2.290
Tour-Dis	0.048	0.046	2.506
Environmental parameters			
Polin-Dis.	−0.057	0.076	8.451
Crem-Dis	0.383	0.194	5.052
Nallah-Dis	1.329	0.210	3.278
Rail L-Dis	0.224	0.143	6.009
Land F-Dis	0.326	0.127	3.028
Slum-Dis	0.083	0.124	7.746
Gar-Dis	−0.689	0.419	3.642
Socio-economic parameters			
Speci C-Dis.	0.442	0.120	7.661
H-Low	0.439	0.130	5.757
H-M	0.007	0.169	1.959
H-High	−0.082	0.249	7.386
Rest-Dis	−0.474	0.175	8.119
Plot attribute parameters			
Appr. R-W	0.056	0.016	9.210
Water S-Ava	−0.526	0.325	2.108
Sewage-Ava	−0.026	0.326	2.960
Planned-P	0.083	0.256	2.186
Height-P	−9.994	19.042	5.878

Confidence intervals are represented as 95%

Table 3 OLS model statistics through SPSS model

Statistic	OLS model
R-squared	0.977
Adjusted *R*-squared	0.966
S.E. of regression	0.728

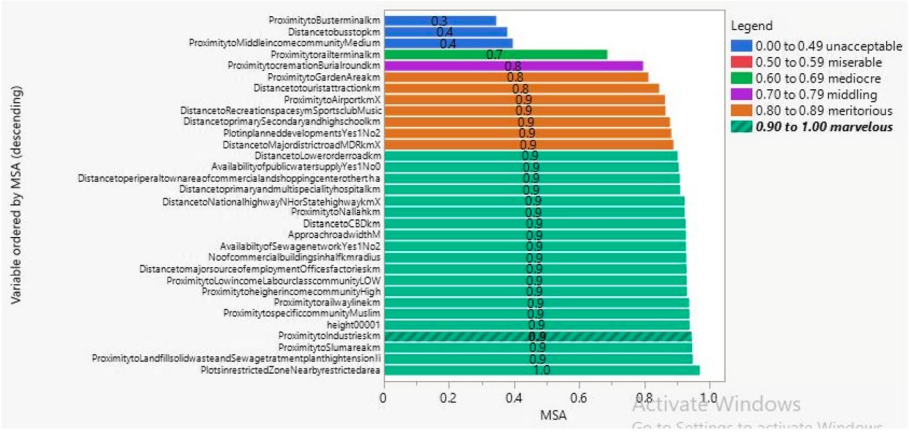

Fig. 13 MSA analysis (JMP Software model)

Table 4 Upgraded OLS regression coefficients through SPSS model

Variable name	Coefficient	SE	VIF
Constant	0.36591	1.228907	
Accessibility parameters			
NH/SH-Dis.	−0.04445	0.357086	3.759417
MDR-Dis	2.486938	0.770086	6.939183
ODR-DIS.	−0.12146	0.594244	7.086096
Airport-Dis	0.02638	0.040997	2.716431
Rail T.-Dis	−0.0702	0.042734	1.469735
Proximity parameters			
CBD-Dis	0.086153	0.066262	7.497159
Per T-Dis	−0.02111	0.088343	2.123015
Com-N	0.014961	0.00622	9.115492
Sch-Dis	−0.0157	0.118645	2.390145
Hosp-Dis	0.107138	0.065187	2.090588
Employ-Dis	−0.20085	0.05928	3.012018
Recre-Dis	−0.0724	0.062837	2.018998
Tour-Dis	0.044269	0.04477	2.385945
Environmental parameters			
Crem-Dis	0.357073	0.17133	3.940579
Nallah-Dis	1.326373	0.201457	3.007797
Rail L-Dis	0.200084	0.12885	4.859798
Land F-Dis	0.348831	0.122383	2.805177
Slum-Dis	0.070256	0.115844	6.736854
Gar-Dis	−0.61243	0.374768	2.899714
Socio-economic parameters			
Speci C-Dis.	0.420749	0.109378	6.370704093
H-Low	0.491794	0.115513	4.560155463
Rest-Dis	−0.41414	0.171156	7.764819914
Plot attribute parameters			
Appr. R-W	0.055474	0.014866	7.538869
Planned-P	0.168184	0.235304	1.844724

Confidence intervals are represented as 95%

Table 5 Upgraded OLS model statistics through SPSS model

Statistic	OLS model
R-squared	0.975153
Adjusted *R*-squared	0.966759
S.E. of regression	0.720072
Akaike info criterion (AIC)	262.9964
BIC (minimum)	312.336

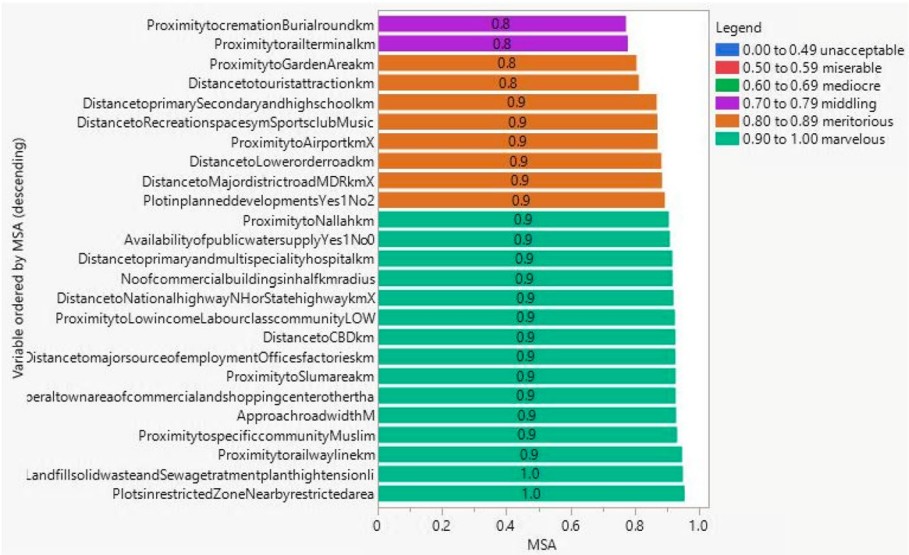

Fig. 14 MSA analysis (JMP Software model)

Among accessibility factors, such as distance to the national highway/state highway, major district roads, and proximity to rail terminals, statistical analysis of the surveyed data reveals that the distance to major district roads holds a significant impact on land value. However, other factors do not contribute as significantly.

Among proximity factors, such as proximity to the central business district (CBD), major employment hubs, the quantity of commercial buildings, and proximity to schools and hospitals, statistical analysis of the surveyed data reveals that the number of commercial buildings in that area as well as proximity to major employment sources (offices) holds a significant impact on land value. However, other factors do not contribute as significantly.

Among environmental factors, such as closeness to garden areas, slum areas, landfills, and industrial zones, statistical analysis of the surveyed data reveals that the proximity to nallah, proximity to landfill area, and proximity to cremation/burial grounds hold a significant impact on land value. However, other factors do not contribute as significantly.

Among socio-economic factors, such as proximity to specific communities, statistical analysis of the surveyed data reveals that proximity to specific communities,

Table 6 Factor's role in affecting land value through SPSS model

Factor S. No.	Land value and its factors	*B*	Value rating (coefficients)	*P*-value	Remark	Rank
		B0	0.36591	0.000	Significant	-
Accessibility parameters						
1	NH/SH-Dis.	B1	−0.04445	0.901	Not so significant	24
2	MDR-Dis	B2	2.486938	0.001	Significant	6
3	ODR-DIS.	B3	−0.12146	0.838	Not so significant	22
4	Airport-Dis	B4	0.02638	0.521	Not so significant	19
5	Rail T.-Dis	B5	−0.0702	0.104	Not so significant	12
Proximity parameters						
6	CBD-Dis	B6	0.086153	0.197	Not so significant	15
7	Per T-Dis	B7	−0.02111	0.811	Not so significant	21
8	Com-N	B8	0.014961	0.018	Significant	9
9	Sch-Dis	B9	−0.0157	0.895	Not so significant	23
10	Hosp-Dis	B10	0.107138	0.104	Not so significant	11
11	Employ-Dis	B11	−0.20085	0.0011	Significant	5
12	Recre-Dis	B12	−0.0724	0.252	Not so significant	16
13	Tour-Dis	B13	0.044269	0.325	Not so significant	17
Environmental parameters						
14	Crem-Dis	B14	0.357073	0.040	Significant	10
15	Nallah-Dis	B15	1.326373	0.000	Significant	1
16	Rail L-Dis	B16	0.200084	0.124	Not so significant	14
17	Land F-Dis	B17	0.348831	0.005	Significant	7
18	Slum-Dis	B18	0.070256	0.546	Not so significant	20
19	Gar-Dis	B19	−0.61243	0.104	Not so significant	13
Socio-economic parameters						
20	Speci C-Dis.	B20	0.420749	0.000	Significant	3
21	H-Low	B21	0.491794	0.000	Significant	2
22	Rest-Dis	B22	−0.41414	0.017	Significant	8
Plot attribute parameters						
23	Appr. R-W	B23	0.055474	0.000	Significant	4
24	Planned-P	B24	0.168184	0.474	Not so significant	18

proximity to low-income area, and proximity to restricted zone hold a significant impact on land value. However, other factors do not contribute as significantly.

Among plot attributes, such as availability of sewage and water supply, statistical analysis of the surveyed data reveals that available road width and plot in planned development hold a significant impact on land value. However, other factors do not contribute as significantly.

The expert opinion serves as a foundational framework for analyzing land values; however, subsequent studies indicate that evaluating land value necessitates a more granular, micro-level approach.

The study primarily focuses on checking the importance of the context and its impacts on land value. The infrastructure or other proposals that may affect land value have not been considered. Various other advanced methods such as spatial regression and

residual methods can be used in further research. This research establishes a strong relationship between different independent variables and land values.

Conclusions

This investigation focused on identifying independent variables that can influence the land value of Jaipur city. The researcher used expert opinions to determine these variables and then tested them using an ordinary least squares (OLS) model to assess their significance. The data collection process involved both online portals and physical surveys to obtain land values of different urban voids in various parts of Jaipur. The locations of these voids were mapped using QGIS with longitudinal and latitude coordinates. Subsequently, the researchers used JMP and SPSS to calculate R^2 (coefficient of determination) and VIF (variance inflation factor) factors, which are common statistical metrics in regression analysis to understand the relationship between variables.

The study concluded that expert opinions can be a valuable starting point for identifying relevant independent variables, but it is crucial to validate them through various statistical methods like regression analysis (OLS) to ensure their significance. It was also noted that different cities may have their unique attributes, and the impact of independent variables on land value can vary significantly from one city to another.

The investigation underscores the significance of comprehending the local context and employing suitable statistical methodologies to discern the determinants influencing land value in specific cities like Jaipur. This study holds the potential to establish diverse toolkits for calculating land value based on the locational attributes of urban voids, allowing administrators and policymakers to judiciously assess and apply charges for sustainable development. These identified factors serve as a guide for urban planners and land managers, ensuring optimal utilization of land. Furthermore, this research can be integrated with other attributes such as zoning regulations, land titles, irrevocable power of attorney, and more, enhancing the robustness of the findings.

Abbreviations

OLS Ordinary least square techniques
SPSS Statistical Package for The Social Sciences

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Authors' contributions

It explained the role of urban void in sustainable development. It provides various factors that can influence the land value of voids. Geo-referenced data has been generated and superimposed on the Jaipur map; then, its data has been collected through e portal and verified through physical survey. Various factors that can influence land value have been gathered through a literature review and then it has been critically examined by the OLS model, and critical factors have been identified for Jaipur city specifically and it was a major contributor in writing the manuscript.
All authors Sanjeev and Manoj worked together in the all-research process, and they have read and approved the manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
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Competing interests
The authors declare that they have no competing interests.

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