

Ambiance through Spatial Organization in Vernacular architecture of hot and dry regions of India – The case of Ahmedabad and Jodhpur

Vibha Gajjar¹ and Foram Bhavsar¹

¹Associate professor, Institute of Architecture & Planning, Nirma University, India

Abstract : Most notable vernacular settlements of the past had a potential of generating stimulating ambiance because of their “organicness”. The understanding of the “Nature of order” in this informality can identify the factors or parameters generating the definite spatial character appropriate for the time and place. The spatial character generates the spirit of the place, what we call the genius loci. This paper analyses the relationship of spatial organization and ambiance of the old city settlements in hot and dry climatic regions of two selected cities of India – Ahmedabad and Jodhpur at various levels. Both the selected cities are informal in nature and rich with its ambiance. Space syntax and digital simulations are used to decode the parameters of the spatial organization. The spatial morphology is analysed using tools such as justified graph analysis, visibility graph analysis, isovists analysis, agent movement analysis and sunlight study. The result of the study is summarised in tabular format and presented in a graphical manner for better understanding. This analysis is valuable in the derivation of the constants and variables to define the learning from the vernacular spatial organization.

1 Overview of Vernacular architecture

The sensibility and logic of vernacular architecture generate quintessential liveable built forms and ambiance of respective settlements. The vernacular has been widely understood as “the architectural language of the people” with its ethnic, regional and local dialects: the product of “non-experts” (Oliver, 2006).

The solutions inherited by vernacular architecture are largely based on necessity, efficiency and prevalent aesthetic sensibilities. The vernacular architecture of any place is based on natural and physical built environment enriched by the cultural heritage of a place and is developed over a long period of time. In the process of growth and evolution, it achieves “wholeness” not only in its totality but also in each fragment. Various building forms are generated in the process of learning from the existing natural environment and building suitably with climatic and social considerations. As a result, the settlements are synergetic with the social, cultural and climatic needs of the region.

1.1 Vernacular architecture of hot and dry regions of India

The Indian subcontinent's diverse range of landform and climatic conditions, such as gigantic Himalayan mountains in the north, Indian ocean in the south, hot sandy desert in the west and wetlands of Bengal in the east have generated varieties of built forms across the country. The natural landscape of the site and response to metaphysical concerns, climate, local proficiencies and construction techniques are the personification of the rich vernacular tradition of built form in India. In each location, the vernacular architecture has evolved in a unique way of response to the context.

Hot and dry climatic zones are experienced in areas far from sea coasts and usually have a low precipitation rate. The most important aspect to be addressed is protection from harsh sunlight and the usual answer is to develop a built form capable of reducing the radiation.

The most preferred solutions in a hot and dry climate are dense clustering of buildings, which allow for the minimum heat gain in buildings. The streets remain shaded in summer providing comfortable temperature throughout the day for outside activities. Hence even in harsh summers, the streets are walkable during the afternoon. The houses are constructed with thick insulation walls, tiny scale openings to keep the hot air outside, and compact clustering of built forms with mutual shading device and provision of the courtyard as a thermal regulator. The harmonious relationship between the thick walls, jalis (perforated openings), courtyards and transitional spaces of semi-private nature is an intelligent approach to deal with the climate.

The spatial character is at the heart of understanding the physical ambiance of any place. The initial step for understanding the spatial character is to understand the spatial organization and the experience attached with it. The interaction of this dense spatial organization with its culture generates the cohesive ambiance within the settlement. Amos Rapoport emphasized that climate, ecology, material, technology, and local economy act as controls rather than factors which affect the spatial ambiance which is articulated as "The built environment creates a specific microclimate for each site as an outcome of building configuration, its orientation, and arrangement in space. Further, the building element interacts with natural macroclimate to determine the factors affecting comfort: light, heat, wind, and humidity.

2 Introduction to Case study

Two cities in different geographical locations and cultural contexts in hot and dry climatic regions of India are selected to study the relationship of spatial organization with ambiance. The city of Ahmedabad located in the state of Gujarat and Jodhpur in the state of Rajasthan are selected for the study purpose as shown in Fig. 2.1.

Ahmedabad is a commercial capital city of the Gujarat state in the western part of India. The origin of Ahmedabad dates back to 1411 when the Nobel Ahmed Shah laid the foundation of the city on the east bank of river Sabarmati.

Jodhpur is the major city of the Marwar region of Rajasthan. Its roots of development are traced back to 1459 when king Jodha of the Rathod dynasty laid the foundation of the city. Both cities were once fortified towns with massive surrounding walls and bastions. In order

to enter the city, Jodhpur had seven gateways, while Ahmedabad had twelve gateways safeguarding the city.



Fig. 2.1 cities on map of India, location of two surrounded by the Rocky Mountains of the Aravalli Hills



Fig.. 2.1.1 Street view of a Pol house in Ahmedabad

2.1 Ahmedabad

The vernacular settlement of the old city in Ahmedabad is known as ‘Pols’. A pol is a gated community having one entrance where a similar group of people or community lives together. These pols are located on the eastern bank of river Sabarmati inside the walled city of Ahmedabad. The densely packed houses are arranged in a linear manner connecting to narrow streets and squares as shown in Fig. 2.1.1. In response to the situation of conflict between the communities and frequent events of riot, the city of Ahmedabad developed a gated community that ensures security and restricts singular access.

2.2 Jodhpur

The spatial organization in the old city of Jodhpur takes into consideration the issues of extreme temperature, solar radiation, glare, sand and dust storms in the development of houses. The houses have flat terraces, open courtyards and projecting balconies with perforated screens. The densely packed houses along the narrow streets breathe through their neighbourhood is formed on the basis of social stratification and occupations, like Brahmins live in Brahmपुरi, goldsmiths in Sunaron Ki Ghati, and moneylenders in Bohron Ki Pol. Most of the courthouses are simple with only minimal entrance decoration. Private terraces are a multifunctional social space of the house, which is used for private functions, social interactions, drying the spices and for sleeping during the hot summer nights. In both cities, houses along the main streets have commercial activity on the ground floor with a residential unit above. Both cities have specific local terminology for various parts of the house as described in the table below.



Fig. 2.2.1 street view of jodhpur city

Table no.1 Local terminology of various parts of a traditional house

Local name	Description and meaning	Spatial characteristic	Spatial Quality
<i>Khadki or Choubara</i>	Entrance or common space shared by a cluster of houses	open	public
<i>Otla or Otta</i>	The transitional space from outside to the inside of the house	semi-open	Semi-public
<i>Chowk</i>	Courtyard of varying scale for light and ventilation (At house & neighbourhood level)	open	Semi-private
<i>Zarookha</i>	The projected place for, shade, sun, light, and breeze usually on upper floors	closed	Semi-private
<i>Parsal or Osri</i>	space inside the house usually surrounding the courtyard	semi-open	Semi-private
<i>Ordo</i>	A private space (rooms) usually closed with openings	closed	private
<i>Rasodu</i>	kitchen usually located near the courtyard as it gives a scope of providing the chimney like structure (Dhumadiyu) attached with fireplace (chulha) for the escape of smoke.	Semi-open	Semi-private

In both settlements, the ambiance is created through the hierarchy of built and open spaces in an unpredictable yet specific order. The spatial arrangement of narrow streets and open spaces, known as “chowk”, act as social spaces for celebrations and social gatherings at a neighbourhood level. The “otla” outside the house acts as an interaction space contributing to the character at a micro level. Thus the physical and metaphysical behaviour of the spatial organization plays an important role in creating a lively ambiance.

2.3 The spatial organization of study areas

A house is an elementary unit in the spatial organization of a street. The morphology is a result of the interaction of a house with the street and the adjacent spaces at a cluster or neighbourhood level. Their spatial relations have an impact on the level of access and control over each other. The interaction of spaces within the house influences social behaviour. The visibility, permeability, movement and circulation patterns of the activity space within the house determines the social behaviour within the house. The built form of a house is the result of the individual needs and aspirations of each community. These structures reveal the understanding of climate, social structure, usage of locally available building materials, and craftsmanship. The courtyards play a significant role in the spatial organization for providing visibility, connectivity, light and ventilation. Further, the lifestyle adoption of users and multifunctional usage of spaces has greatly influenced building configuration and form. The size of family units, spatial usage, preparation of food, interaction of people and many other cultural considerations also affects the layout and size of dwellings (Rapaport, 1969).

In both case studies, the cluster formation is not following a rigid geometrical pattern allowing the degree of flexibility in spatial organization. The amalgamation of spatial organization and sensorial experiences generates the spirit of the place. This spirit of the

space defines the special character of any particular place. In order to understand the ambiance of a place at a varying level from neighbourhood, cluster and house level the analysis of spatial organization plays a pivotal role. The symbiotic relationship of the forms of mass and space in architecture can be examined and found to exist at several scales (Ching, 2007). The detailed understanding of the spatial organization would be created using documented case studies for the city of Ahmedabad and Jodhpur.

3 Study area

3.1 Case study selection

The selected area for the study purpose is located in the old fabric of Ahmedabad and Jodhpur as shown in Fig. 3.1.1(a) & (b). Both areas belong to Hindu dominant community having a similar religious background and were built 100 to 200 years ago. The cultural background differs due to the social structure and regional differences. The analysis is done at three levels :

1. Neighbourhood of 200-300 houses
2. Cluster of 6-8 houses
3. Individual dwelling unit

The paper examines and analyses the physical spatial organization at various levels to understand the spatial character of a place. It examines important factors that play a vital role in creating a definite spatial organization. Each factor is examined using various analysis methods and derives the constants and variables in both the case studies. It further evaluates the reasons, which are socio-cultural or climatic for the variables that are specific.

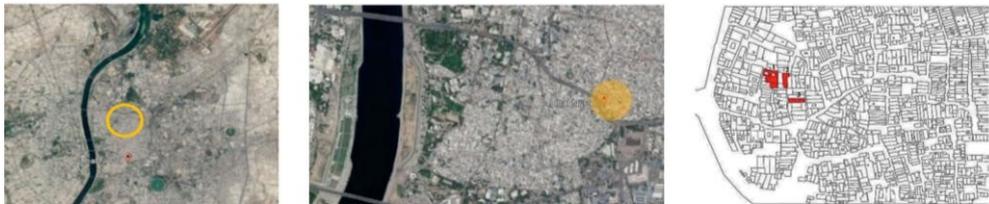


Fig. 3.1.1 (a) The figure shows the location of the study area in Ahmedabad at three levels City (Ahmedabad) – Area (Khadia) – Neighbourhood (Dhal ni pol)

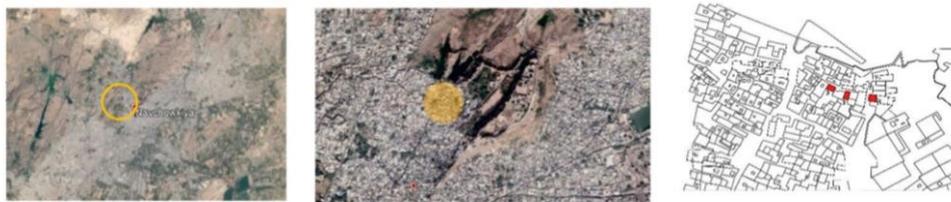


Fig. 3.1.1 (b) The figure shows the location of the study area in Jodhpur at three levels City (Jodhpur) – Area (Brahmpuri) – Neighbourhood (Fatehpol) to the site.

3.2 Method for spatial analysis

The space syntax analysis method is used for the purpose of spatial organization analysis. Space syntax tool is simply a way of transforming buildings into dimensionless forms to interpret spatial organization using graphical representation. Along with space syntax, the climatic analysis is done for the available sun hours and shadow patterns in summer and winter months. The analysis is done using a three-dimensional model to examine the results on the building surface as well as on the streets. The analysis generates the graphs and data indicating the behaviour of the space and behaviour of a user at a particular space.

3.2.1 Justified graph analysis

The justified graph is a tool to find out the relationships between the spaces. This method is used for understanding the adjacency of spaces at various scales such as adjacency of streets, clusters, houses and activity spaces within the house. The graph generated shows space as nodes, and line as connected spaces or edges. The dark thick lines in the images represent the main axis and the lighter and thinner lines represent the secondary, as well as the tertiary axis. The bigger dots in the diagram denote the nodes/convex spaces (the spaces between the houses) and the smaller dots denote the houses. The lines indicate the connectivity between the nodes and the houses. The figures below from 3.2.1(a) and (b) show the graphical presentation of Axis and J-Graph analysis at the neighbourhood to house level.

3.2.2 Visibility Graph, Agent movement and isovist analysis

The visibility graph analysis (VGA) is used to check the visibility and permeability as a dynamic component in spatial organization. This analysis will help in the revelation of the hierarchy of spaces from public to private and knowing the locations which remain directly visible or invisible through a colour-coding diagram. The colours from cyan to blue suggest low connectivity, and yellow to red suggest high connectivity. In order to find the natural movement pattern in the building, the Agent's model developed by Alasdair Turner is used for analysis. This helps in understanding the natural path of movement in the way of finding. It also helps in getting insight into private and territorial behaviour. The spatial quality of architectural space can be analyzed using Isovists. The potential field of view from the identified location can be generated using isovists. The depth map creates polygons and helps to measure the depth of each identified location and its relation with each other. A well-integrated location is colored in red which implies the shallowness, means no turns are required to get from one location to the other. The poor-integrated location is coloured in blue which implies the turns and depth with respect to their locations.

3.2.3 Sunlight hours and Shadow analysis

Sun and wind are the most essential cosmic attributes, as discussed earlier. The sunlight hours analysis is generated using the ladybug component of grasshopper on Rhino. This component calculates the direct sunlight received by any geometry in any given climatic zone. It further helps to understand whether the indoor and outdoor spaces are comfortable to use or not. Both selected cities have a similar climate. The studies are done on both surface and base levels to understand the behaviour of streets and house surfaces with respect to the climate. Low rise and high-density fabric of both the cities have narrow streets, pedestrian pathways and open chowks (open gathering spaces). Instead of such similarities, the study suggests relatively different results for both cities. The graph below shows the indication of hours of

sun during the day time. The cold colours from blue to dark red suggest the fewer hours of sunlight where the warm colours from red to yellow suggest more hours of sunlight.

	AHMEDABAD		JODHPUR	
SITE (Axis diagram)				
Axis	<ul style="list-style-type: none"> - Two main axis - internal axis and outer axis (Shown in varying thickness in the figure above) The outer axis is the main link between the east and west side of Ahmedabad - Internal primary axis is crooked - The relatively leveled ground around the primary axis 		<ul style="list-style-type: none"> - Jodhpur has a single central primary axis which connects the neighbourhood to the other part of the city - Internal primary axis is continuous - The terrain is rising up towards east-west direction suggesting the primary axis at the lowest ground 	
Orientation	<ul style="list-style-type: none"> - The outer primary axis is in a north-south direction; the internal primary axis is in an east-west direction - The major number of secondary axis is in the north-south direction - The houses are oriented along the streets; mainly in an east-west direction to get better sunlight and ventilation within the house 		<ul style="list-style-type: none"> - Primary axis is in the north-south direction - The major number of secondary axis is in the east-west direction along the terrain - The houses are oriented along the streets; In case of Jodhpur the houses face all four directions; the main source of light and ventilation is the courtyard 	
Adjacency	<ul style="list-style-type: none"> - All the houses open up on the shorter side of the house to get better accessibility to pathway and services 			
CLUSTER (Axis and J-Graph diagram)				
Axis	<ul style="list-style-type: none"> - The houses are arranged in a linear manner along the north-south streets - Linear but fragmented streets with more intersections between streets - Clusters are linear and smaller in size 		<ul style="list-style-type: none"> - The houses are arranged in the cluster (Square clusters) manner along the north-south streets - Linear and less fragmented streets with fewer intersections between streets - The clusters are square in form and larger in size 	
Organization	<ul style="list-style-type: none"> - Suggests good connectivity and accessibility of houses along the street 			
	<ul style="list-style-type: none"> - Linear organization of houses along the streets facing north-south direction - The houses are oriented along the streets; mainly in the east-west direction to get better sunlight and ventilation within the houses 		<ul style="list-style-type: none"> - Cluster organization along the streets in all directions due to the availability of fairly flat land on the terrain - The houses face all four directions; the main source of light and ventilation is the courtyard 	
Connectivity	<ul style="list-style-type: none"> - Many nodes are connected along the axis - Many individual houses are connected to each node 		<ul style="list-style-type: none"> - Relatively fewer number of nodes are connected along the axis - Fewer number of houses are connected to each node 	

Fig. 3.2.1(a) Analysis of Axis & J-Graph diagram at neighbourhood & cluster level

	AHMEDABAD		JODHPUR	
TYPICAL LAYOUTS (J-Graph analysis)		<ul style="list-style-type: none"> 10 11 12 ROOM 9 ROOM 8 ROOM ROOM & KITCHEN COURTYARD ROOM OSRI / VESTIBULE - ROOM ENTRY STEPS TOILET 5 4 3 2 1 		<ul style="list-style-type: none"> 10 ROOM 9 ROOM ROOM ROOM KITCHEN & WASHROOM COURTYARD TOILET OSRI / VESTIBULE - ROOM ENTRY STEPS 7 6 5 4 3 2 1
	Large size house			
		<ul style="list-style-type: none"> 11 ROOM 10 ROOM 9 ROOM ROOM BATHROOM, KITCHEN & STORE COURTYARD STORE OSRI / VESTIBULE ENTRY STEPS TOILET 4 3 2 1 		<ul style="list-style-type: none"> ROOM ROOM ROOM ROOM KITCHEN COURTYARD TOILET OSRI / VESTIBULE - ROOM ENTRY STEPS 10 9 8 7 6 5 4 3 2 1
Medium size house				
	<ul style="list-style-type: none"> 10 ROOM KITCHEN & STORE ROOM COURTYARD BATHROOM STORE OSRI / VESTIBULE - ROOM ENTRY STEPS TOILET 5 4 3 2 1 		<ul style="list-style-type: none"> ROOM ROOM ROOM COURTYARD KITCHEN OSRI / VESTIBULE ENTRY STEPS TOILET 8 9 7 6 5 4 3 2 1 	
Medium size house				
Entry	<ul style="list-style-type: none"> - Direct entry from the street - Public space (otla) at the entry of a house - Toilet at the entry for easy access to the services (pipelines) 		<ul style="list-style-type: none"> - Indirect entry - Use of change in direction and steps to disconnect from the street - The entry has high-steps which act as public space; Otla are visible only along the primary street - The toilet is located near entry – no pipelines but open drains along the terrain 	
Adjacency	<ul style="list-style-type: none"> - Linear adjacency of spaces; Branching of the spaces is taking places only along the semi-private spaces (Osri/vestibule and Courtyard) - Osri/vestibule or Courtyard is connected to services- Toilets and Kitchen - Access to private spaces (rooms) through the other private spaces 		<ul style="list-style-type: none"> - Adjacency of the spaces suggest the branching at private and semi-private levels - The courtyard is connected to services- Toilets and Kitchen - Access to private spaces (rooms) through the passage around the courtyard 	
Centrality	<ul style="list-style-type: none"> - Courtyard 		<ul style="list-style-type: none"> - Courtyard 	

Fig. 3.2.1(b) J-Graph diagram at a unit level ● Private spaces ● Semi private spaces

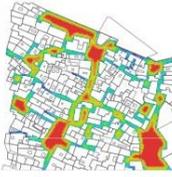
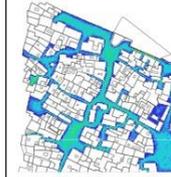
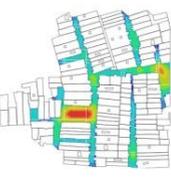
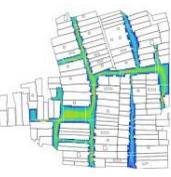
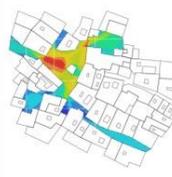
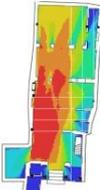
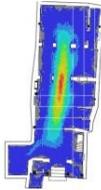
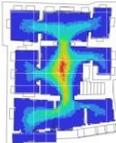
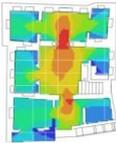
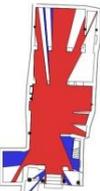
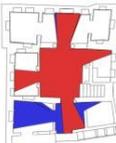
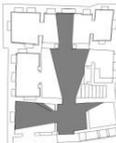
	AHMEDABAD		JODHPUR	
	Visibility	Agent Movement	Visibility	Agent Movement
SITE AND CLUSTER				
				
Visibility	- Less visibility of nodes - Movement and visibility along the periphery		- Higher visibility of nodes - Movement and visibility along the central axis	
Connectivity	- Nodes are higher in number and smaller in size		- Nodes are lesser in number and larger in size	
Privacy	- Privacy is attained by means of the organization of streets – Privacy is greater in the centre		- Privacy is attained by means of the terrain – Privacy is greater away from the centre along the terrain	
	Visibility	Agent Movement	Visibility	Agent Movement
TYPICAL LAYOUT				
	Isovist - Court	isovist - Entry	Isovist - Court	isovist - Entry
				
Visibility	- Linear visibility along the axis connecting all the semi-private spaces		- Visibility mainly in the central area along the courtyard	
Connectivity	- The private spaces (rooms) are partially connected with the semi-private areas		- The private spaces (rooms) are disconnected from the semi-private areas	
Privacy	- Streets are relatively more private in nature than Jodhpur - The house entry / ota work as a public space		- Streets are relatively public in nature – greater privacy along the terrain - Houses are very private in nature due to the socio-cultural reasons	

Fig. 3.2.2 Visibility graph analysis at neighbourhood, cluster and unit levels

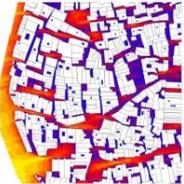
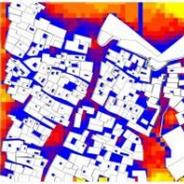
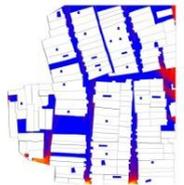
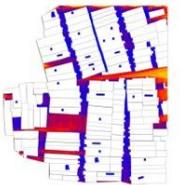
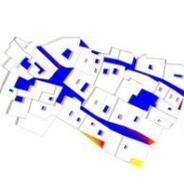
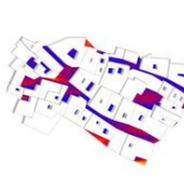
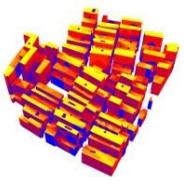
	AHMEDABAD		JODHPUR	
	Winter	Summer	Winter	Summer
SITE AND CLUSTER (On ground)				
				
Sunlight	- Main and secondary streets are shaded in summer and winter; It allows a good comfort level in summer but remains cold in the winter time - Only larger nodes receive adequate sunlight in the winter time - Terraces receive good sunlight in summer and winter - Depending on the adjacent condition all the houses might not get enough sunlight throughout the day		- Main and secondary streets are relatively less shaded in winter and summer; works well in both winter and summer time - All the nodes receive reasonable sunlight during the winter time - Terraces receive very good sunlight in winter due to the terrain - All the houses get sunlight on the walls and terraces due to the terrain (The terrain generates stepped terraces)	
Daylight	- Longer hours of daylight in summers than winter time; the courtyard is the main source of energy within the house		- Longer hours of daylight in summers than winter time; the courtyard is the main source of energy within the house	
	- Relatively fewer hours of daylight in the house throughout the day due to the dense street configuration		- Relatively more hours of daylight in the house throughout the day due to the terrain	
	Winter	Summer	Winter	Summer
CLUSTER (On building surface) 1) Sun hours analysis 2) Shadow analysis				
	Shadow analysis			
				
Shadow	- All the internal streets are shaded in the summer time		- All the internal streets are shaded in the summer time	
	- Terraces are more shaded as compared to Jodhpur		- Terraces are less shaded and act as a good source of sunlight in the winter time	

Fig. 3.2.3 Sun hours and shadow analysis at neighbourhood and cluster levels

Conclusion

The comparative study of the selected case studies derives the constants and variables of the spatial organization that are responsible for the ambiance of the respective place. The constants are due to the hidden order in its organicness. The variables are due to the specific site conditions and dissimilar social structures. The results of the space syntax analysis and simulations derive the parameters affecting the spatial organization and ambiance generated with that organization. The constants are the result of climate responsiveness in both the settlements. The orientation of the houses promote better daylight and ventilation at the same time protects from the harsh sunlight during the summer season. The street orientation is a response to the existing landform, access and services. Both settlements provide a comfortable temperature in the summer season. The spatial organization of houses in the street responds to accessibility and privacy at the same time. Privacy here is understood both as physical and visual component. The physical component connects or disconnects various levels of accesses at thoroughfare, street or cluster respectively. The visual component is responsible for the sense of safety and connections between people. The city of Ahmedabad shows the character of the planned street as a decisive and conscious effort for achieving privacy. The character becomes more public and inviting at a cluster level. The neighbourhood street is a private entity hence the *otla* outside the house is the most public space used for interactions. This hierarchy of private to public at neighbourhood to house level generate the lively ambiance within the neighborhood. In Jodhpur, privacy is attained at a house level where the streets are public in nature hence the house edge is the threshold between public and private space. The social structure in Jodhpur necessitates the privacy from the public street. The house orientation and planning encouraged privacy. In both cities, the courtyard is the ultimate source of light and ventilation. This multifunctional space is the center of the house. Both the places have developed their own vernacular vocabulary appropriate for the time and place. The constants in both the case studies are relevant learning for any hot and dry climatic region with a similar background. The variables have more specific learning of the relationship between social behaviour and spatial organization. Altogether, they provide us with a concrete understanding of the vernacular spatial structure and specific ambiance they generate.

References

1. Oliver, Paul. *Built to meet Needs Cultural Issues in Vernacular Architecture*. Burlington, MA: Architectural Press Elsevier Ltd., 2006.
2. Rapoport, Amos. *house form and culture*. N.J.: Prentice Hall, Inc., 1969.
3. Rudofsky, Bernard. *Architecture without Architects*. New York: Connecticut Printers, Inc., Hartford, Connecticut, 1965.
4. Fathy, Hassan. *Vernacular Architecture*. Ed. Walter Shearer and Abd-el-rahman Ahmed Sultan. Chicago: The University of Chicago Press, 1986.
5. Patel, Dr. Manek. *Welcome to Ahmedabad: a complete city Guide*. Ahmedabad: Gurjar Prakashan, 2010.
6. Hanson's, Hillier and. *The Social Logic of Space*. London: Cambridge University Press, 1984.
7. Dongre, Neeta Lambe & Alpana. "Analysing Social Relevance of Spatial Organisation: A Case Study of Traditional Pol Houses, Ahmedabad, India." *Asian Social Science*; Vol. 12.No. 9 (2016).

8. Mihir Vakharia, Rajan Rawal, Yash Shukla, Agam shah. "Summer in Ahmedabad: pol House performance." *Indian Architect and Builder* 1 October 2014: 10.