Vastu Shastra towards Sustainable Development Impacting the Quality of Urban Life

[1]Sneha Maji, [2]Mahima Jain

[1]Assistant Professor, Department of Architecture and Planning, Indira Gandhi Delhi Technical University for Women, Delhi, Email ID: snehamaji@igdtuw.ac.in

[2]B. Arch 5th Year, Department of Architecture and Planning, Indira Gandhi Delhi Technical University for Women, Delhi

Abstract

The role of Vastu in programming for promoting sustainability in natural-resource use is based on a lifecycle approach to long-term productivity. Such a system needs an appropriate legislative, regulatory, and fiscal framework to encourage individuals, communities, and businesses to meet sustainable development goals. Further, improving the liveability and enhancing the quality of life for the rapidly growing populations of developing countries like India cannot be achieved by following the same energy-consumption and resource-use patterns as developed countries. This study discusses *Vastu Shastra* (an ancient Indian knowledge of architecture) with sustainable development. It informs the complicated problems of urbanisation and overpopulated cities of today. By drawing attention towards *Vastu Shastra*, this paper discusses the built form of Indian settlements and explores the possibility of creating a living environment that is self-sufficient, ecologically balanced and culturally stimulating. It explains sustainable development based on ancient Indian traditional knowledge through its culture, heritage and orientation towards sustainability. Further, the fundamental principles, the relevance of *Vaastu-Purusha-Mandala*, and *Vastu Shastra*'s history are highlighted with discussions on its philosophical and social aspects. Last, an attempt has also been made to create a close relationship between Vastu Shastra and sustainable development that can redefine the present form of planning human settlement. In this way, by drawing attention towards Vastu Shastra, this paper explores the possibility of creating a living environment that is self-sufficient, ecologically balanced and culturally stimulating.

Key Words: Vastu Shastra, Quality of life, Sustainability, Urban fabric, culture, ecology.

1.0 Introduction:

The concept of "quality of life" represents more than the private "living standards" and refers to all the elements of the conditions in which people live: all their needs and requirements. This concept has been developed by social scientists to measure and evaluate people's well-being, satisfaction and happiness. It demands, amongst other things, available and accessible social and public infrastructure to satisfy the needs of those involved and affected by it and an environment without severe deterioration or pollution. Such conditions are not generally met in our cities since a large part of the inhabitants live in dwellings and neighbourhoods lacking basic facilities and services. Milbrath states that "if quality of life is defined as happiness or well-being or satisfaction, it is necessarily subjective"; thus, the objects which we value positively provide that value to our life quality (Milbrath, 2000, p. 4). Solomon and et al (2000) points out that the evaluation we make of the environment involves more than a detailed interpretation of it; it is a global and affective reaction which is strongly influenced by ideal images that are of a subjective nature.

Although the concepts of quality of life and environmental quality show considerable overlap, they are not identical: some elements of happiness have their causes on the individual. Some people are able to feel happy even in the worst environmental conditions, while others cannot be happy even in the best environmental conditions. In recent years, life quality studies have fundamentally concentrated on urban nature and the quality

of urban life. The concept of quality of life is a complicated and multidimensional issue. Therefore, there is no need to say that this concept can be applied in planning only when appropriate and reliable frameworks exist for its measurement. Indeed, urban planners, politicians, statesmen, non-governmental organisations and the public try to influence planning processes and outputs to change conditions, improve life quality and provide an environment in which the quality of life is enhanced.

This study develops a theoretical framework regarding to the concept of quality of life and seeks to delimit its scope to derive a subjective assessment for researches that can help to improve the quality of life in urban settlements. In this case, the scale is applied to the Jaipur. In the recent past there has been intervention in newer settlements of Jaipur keeping in pace with the rise in population. Figure 1 shows the phase-wise growth of the city of Jaipur. However, surprisingly these kinds of interventions have significantly impacted the quality of life of its citizen in terms of cultural and social values and environmental sustainability. Frequent cases of poor water management and traffic congestion is reported. It is considering a lack of empirical studies in the field of life by assessing life quality indices in the city of Jaipur as a sample case.
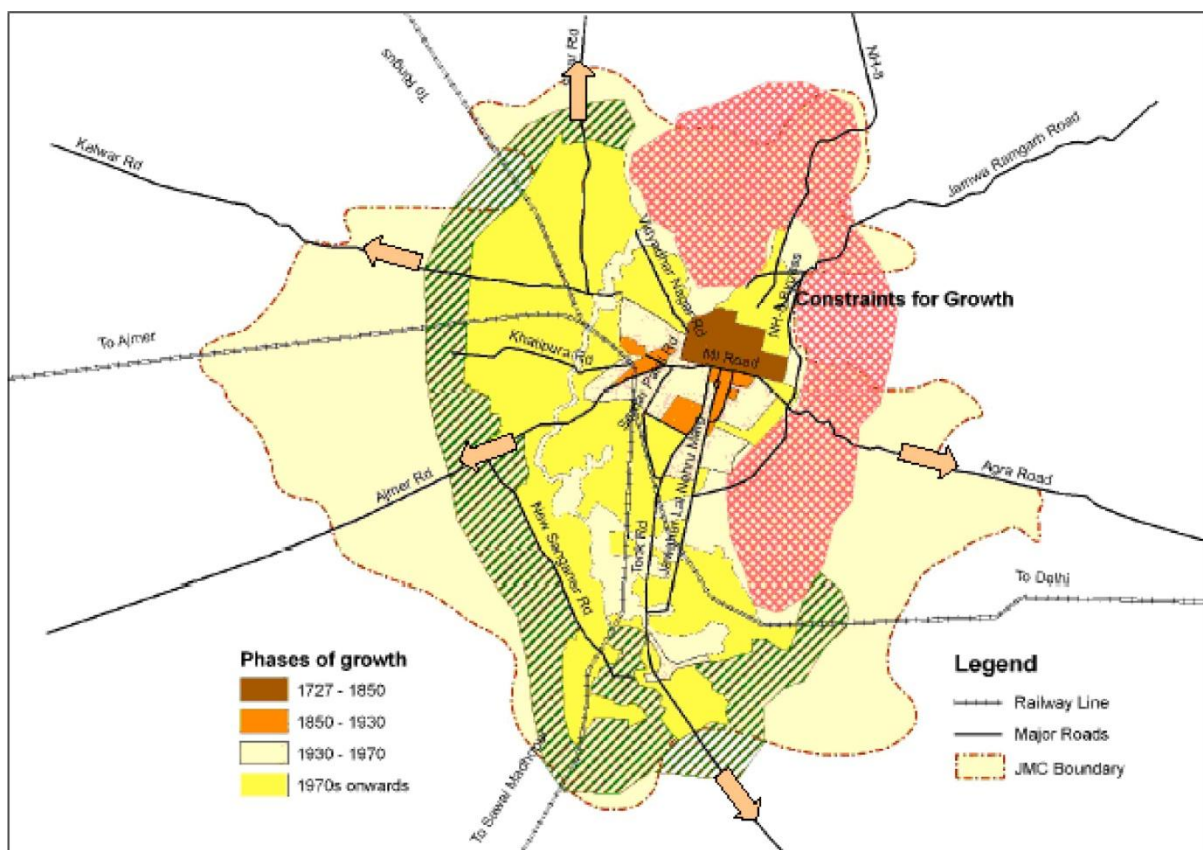

Fig. 1. Map showing phase-wise growth of Jaipur City. Source: Jawaid et al., 2017.

1.1 Current situation of quality of life in Urban India:
Nowadays, it is important to evaluate the quality of urban life to define public intervention priorities and evaluate problems to ensure that the policies developed are compatible with the local context. Citizens and stakeholders have high expectations, both in terms of quality and quantity, and city decision-makers need to monitor their smart

city strategy's impacts over time while reflecting on how the city can become more imaginative. Technological solutions often overemphasise in solving urban designs issues, and they sometimes overlook local socio-cultural needs. 'Smart city concept gives more attention to cities' environmental quality, unlike 'digital cities', which focuses more on the use of Information and Communication Technologies (ICT) in urban areas. Smart Sustainable Cities (SSCs) ' four key attributes are Sustainability, Quality of Life, Urban aspects and Intelligence with four core themes as Society, Economic, Environment, and Governance (Kondepudi, 2015). Kondepudi, points out that a smart sustainable city is characterised as the one with following goals to be achieved in a flexible, reliable, scalable, accessible and resilient manner:

1. Improve the quality of life of its citizens.
2. Ensure economic growth with better employment opportunities.
3. Improve the well-being of its citizens by ensuring access to social and community services.
4. Establish an environmentally responsible and sustainable approach to development.
5. Ensure efficient service delivery of essential services and infrastructure such as public transportation, water supply and drainage, telecommunication and other utilities.
6. Ability to address climate change and environmental issues.
7. Provide an effective regulatory and local governance mechanism ensuring equitable policies.

There are different aspects for life quality from diverse fields such as political sciences, geography, planning, economics, psychology and sociology; the definition of each of them indicates their attitudes toward this issue and the manner it is used in different sciences. For example, in one study on quality of urban life' in Guwahati in northeast of India, Das divided the urban environment into three subsets of physical environment, social environment and economic environment and assessed life quality in each of these dimensions (Das, 2008, p. 301).Also a study conducted in Kolkata linked spatial urban forms with the dimensions and patterns of the urban quality of life in the high-density area by considering basic amenities, assets, land-use, and accessibility Gopal (2002) . To the best of the author's knowledge, none of the past studies deemed Vastu Shastra and its inherent sustainable properties investigating its contribution in improving urban life quality, as demonstrated in the latter part of this chapter.

Dividing the living environment into its different constituting components can be also identified in older studies which were seeking for the measurement of quality of life such as the research conducted by Economic Co-operation and Development Organization on the development of social indices of welfare measurement in which environment was divided to two physical-environmental and social-economical dimensions (Jalayer, 2009, p. 34). In addition to these studies, researchers (psychologists) like Schneider (1975), Schalock (2004) and Diener (2000) also considered personal attitude toward life as the first determining factor of quality of life and thus made an emphasis on the mental aspect of life quality.

According to the present study, quality of life includes physical-environmental, social, economic and psychological dimensions. Therefore, these dimensions can be used to detect the concept of stability and vitality and determine the meaning of life quality.

1.2 Role of Vastu Shastra towards increasing quality of life through the lens of sustainability*:*

The central concept of Vastu Shastra is to facilitate a harmonious relationship between human beings and the environment, which leads to sustainable development. By examining ancient Vastu Shastras (texts), one can find that green building and sustainability are not new concepts. The great scientist and architect *Brahmarishi Mayan* brought out similar ideas more than ten thousand years ago when he developed the Vastu Shastra and Agamas based upon the opinions found in Mayan's Aintiram and Pranava Veda as mentioned by Mayamata(1985). So the term sustainable development and Vastu Shastra brings together two strands of thought about the management of

human activities – one concentrating on development goals and controlling the harmful impacts of human activities on the environment (United Nations Centre For Human Settlements (Habitat), 1991). The fundamental nature of ecological planning is that the buildings and open space should adapt minimum disruption to the land-forms. Further, the energy of a Vastu building and settlement planned as per the Vastu Purusha mandala contributes profoundly to the well-being of the inmates and the community at large in the present and the future. The principles of Vastu should be brought together and coordinated through management to achieve a sustainable living condition in all aspects of development.

The role of Vastu Shastra in promoting sustainable development would include the following:

1. Devising settlement systems and settlement plans that lead to resource-efficient and affordable transport patterns, e.g., by promoting short-distance and long-distance mobility;

2. Developing programmes for economising on the use of non-renewable energy sources and for adapting settlements to the use of renewable energy systems;

3. Providing water-supply, sanitation and waste-processing and recycling systems that meet basic needs in a resource-conserving manner;

4. Promoting the use of indigenous building materials and appropriate construction technologies, among other things, by revising building and planning codes supporting small-scale production processes. To bring balance between human settlement and nature, Vastu Shastra contributes two central development goals – productive, innovative economies and high-quality living environments, also providing an essential mechanism for sustainably managing natural-resource use. It also includes support schemes to

(a) Conserve, recycle, re-use or reclaim materials or energy currently discarded or wasted (Tsai, 2008),

(b) Identify and put into use unused or underutilised resources,

(c) Implement pollution-control measures and adjustments to pricing structures so that these contribute to sustainability and development goals, and

(d) Forge partnerships with low-income groups and their community organisations to address housing and environmental health problems.

Currently, India is focusing on urbanisation and the Smart City concept is gaining ground rapidly. The urbanisation agenda is in two parts viz. Atal Mission for Rejuvenation and Urban Transformation (AMRUT) which is focusing on the urban rejuvenation of 500 Indian cities and Smart Cities, which is focusing on area-based development, greenfield development and pan-city development of 100 eligible Indian cities (Ministry of Urban Development (MoUD), 2015). However, the learnings of various factors contributing to the vibrant liveability of old settlements has perhaps gone missing and their importance is not yet realised beyond the prospects of tourism. The traditional Indian cities are characterised by multiple uses of spaces, the fluidity of movement (Narayanan, 2014), compact and dense settlements, social interactions, natural drainage and water management planning and diversification of economic linkages (Dhingra, 2014; Dhingra &Chattopadhyay, 2015) but the existing urban planning framework is probably not enough for its historical cities and needs a socially inclusive visioning of community-based approach for sustainable urban regeneration (Deakin, 2011. Further, Narayanan (2015) points that uncritically imposed planning policies in developing countries like India, without considering its socio-cultural and historical variations of place and community, has a high risk of failing or even intensifying existing social and environmental injustice. To develop planning policies which integrate social, cultural, political and environmental needs of existing cities, a localised sense of place may be required. The introduction of modern construction technology and western planning methods has affected eastern societies' traditional practices (Blake & Lawless, 2016). However, some historic Indian cities still have conventional Vastu based urban plans alive though the modern economic and social shifts are visible in these centres. Itis argued that the problem arises when the buildings are given more importance in contemporary construction than their inhabitants (Narayanan, 2015).
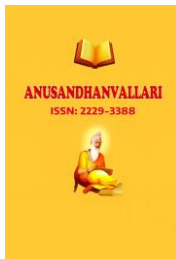
Literature reports have also opposed the insensitive and incongruent modern planners' approach for such old settlements with a complex social system and values (Spodek. H, 2013).
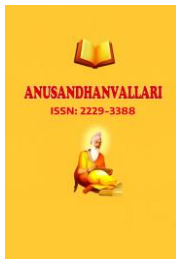
Until now, researchers have used two basic approaches to examine the quality of urban life: the objective process, which typically confines to analysing and reporting secondary data—usually aggregate data that are mainly available from official government data collections, including the census, at different geographic or spatial scales—and the subjective approach, which uses social survey methods to collect primary data at the disaggregate or individual level, and focuses on peoples' behaviours and assessments, or their qualitative evaluations of different aspects of urban life. Since 2014, 34 Organisation for Economic Cooperation and Development (OECD) countries have attempted to collect data about people's well-being several times a year. Comparisons are made using nine criteria—these include access to services, civic engagement, the environment, individual incomes, employment, and education—with open data being made available to researchers and citizens.

This study aims to develop a measurement framework that can be used to interpret and integrate aspects of citizens' urban life quality by analysing interactions between urban and environmental systems and between critical resources and their influences on the environment. The research aims to use the structure of the old walled city of Jaipur to demonstrate that Vastu architecture has been a forerunner in sustainability for thousands of years.

2.1 Designing of the Indicators Criteria

In order to identify the applicability of the ancient design methods of Vastu in the context of modern Smart Cities of India, a set of parameters were identified based on prevalent literature. Several reports of suggested parameters are available. For example, Dumreicher et al. (2000) has empathised assessment of a city planning on the basis of compactness. Compactness has been argued to decrease the commuting distance, which has increasingly become a wasteful aspect of city living (Sherlock 1990, 53). Carl et al. has pointed out that in a wider sense, sustainable cities also need to consider density since density and dwelling type affects sustainability through differences in the consumption of energy, materials and land for housing, transportation and urban infrastructure Walker et al. points outs that high density and integrated land use not only conserve resources but provide for compactness that encourages social interaction (Walker and Rees 1997). Parker mentions that mixed-use or heterogeneous zoning allows compatible land uses to locate in close proximity to one another and thereby decreases the travel distances between activities (Parker 1994). Jane Jacobs has popularised the diversity dimension, such as new urbanism, smart growth and sustainable development in today's time. Owen points out the parameter of passive design since it is assumed that design, siting, orientation, layout and landscaping can make the optimum use of solar gain and microclimatic conditions while minimising the need for space heating or cooling of buildings by conventional energy sources (Owens 1992). Interaction between energy systems and urban structure takes place at all spatial scales from the regional, city and neighbourhood of the individual building (Owens 1992, 81-82). New urbanism advocates design-based strategies based on traditional urban forms to help arrest suburban sprawl and inner-city decline and build and rebuild neighbourhoods and cities. Charles Bohl (2000) argues that new urbanism is an approach to planning and design that draws on historical precedents for ways to blend different combinations of housing types in the form of neighbourhoods, rather than superblocks, suburbs, or projects.

To arrive at a shortlist of parameters, the authors have constructed the criteria from understandings of literature affecting the Urban spatial quality. Following these considerations, indicators in the study were selected based on the following criteria: objectivity (clear, easy to understand, precise, and unambiguous); relevance, measurability, and reproducibility (quantitative, systematic observable); validity (with the possibility of verification and data quality control); representativeness (at the city level); comparability (over time); and accessibility (available databases, use of existing data). The

parameters were evaluated by five experts in the domain with a content validity index of 0.9 and a content validity ratio of 0.88.

Further, the scale which has been developed for the assessment of the identified urban elements which through literature study has shown to impact the quality of life. A scale of 3 points has been proposed for each parameter where 1 represents a low level of sustainability, 2 represents a moderate level of sustainability, and 3 represents a high level of sustainability. In the present study, seven parameters have been selected to assess traditional settlements' urban fabric and are termed as smart urban elements leading to inclusive and sustainable communities. Each of these parameters has an overlapping influence on sustainability from social, economic, and environmental paradigms. These identified seven urban elements are listed with their intent below:

1. **Compactness**: Compactness has been considered as a parameter for sustainable smart urban planning as it ensures citizens walkability and thus reduced energy usage which in turn promotes high quality of life in terms of social interactions, access to community services, mutual shading of buildings and also reduced travel demand for day to day activities.
2. **Mobility:** Mobility assessment is envisioned to help understand the travel demands and accessibility to services. It is very likely that car use will decline in neighbourhoods designed with more pedestrian-friendly features, such as a connected street layout
3. **Density:** This parameter is chosen since viable interactions between urban functions and activities make efficient use of scarce natural resources and urban land. This also can reduce automobile ownership and travel demand.
4. **Land use mix:** This parameter ensures safety on the streets, reduces the number of trips and increases accessibility. Effective land use of a city makes local streets attractive, boosting local creative economy and handicrafts and increasing neighbourhood charm.
5. **Diversity:** This parameter ensures that the interaction of people in various socio-economic activities is encouraged. Diversity inbuilt also ensures attractive and vibrant urban landscapes, which can increase the quality of life.
6. **Use of Passive solar design:** This parameter favours microclimatic conditions, reduces cooling and heating energy consumption and is environmentally viable. This also preserves and promotes local craftsmen skills. Round the year thermal comfort ensure better productivity and enhanced quality of life.
7. **Green urbanism:** This parameter favours microclimate for children to play, generates open spaces for social interaction and promotes participative decision making.

2.2 Application of indicators selected: Assessment is important to understand whether our traditional settlements have been smart in their approach to urban planning and, hence, assess our baseline situation to move to the next level of introducing ICT and other urban engineering solutions. The parameters thus identified are applied to determine the quality of planning of India's ancient cities, which were developed using the planning principles as discussed in the ancient treatise of 'Vastu Shastra' and has lived to this modern day.

S.no.	Smart urban elements	Indicators	Evaluation criteria
1.	**Compactness**	Dwelling unit density	High = 3; Medium= 2; Low = 1.
2.	**Mobility**	Home to work distance Internal connectivity External connectivity Street layout	Low = 3; Moderate = 2; High = 1 Good = 3; Medium = 2; Bad = 1 Good = 3; Medium = 2; Bad = 2 Well Connected = 3; Moderately connected = 2; Poorly connected = 1
3.	**Density**	Persons per hectare Commuter mode choices	High = 3; Medium = 2; Low =1 Walking/Cycling = 3; 2-Wheeler = 2; 4-wheeler = 1
4.	**Land use mix**	Mixed residential land use Walkability to city centre Walkability to social services Mix of commercial and residential land uses	High = 3; Medium = 2; Low = 1 High = 3; Medium = 2; Low = 1 High = 3; Medium = 2; Low = 1 High = 3; Medium = 2; Low = 1
5.	**Diversity**	Building typology Socio-cultural mix Local creative economy Income groups	Varied = 3; Moderate = 2; Not Varied = 1 Heterogeneous = 3; Moderate mix = 2; Homogenous = 1 Varied and Flourishing = 3; Stagnant = 2; Negligible = 1 Heterogeneous = 3; Moderate mix = 2; Homogenous =1
6.	**Passive solar design**	Orientation and Siting Building layout Facade and fenestration Building techniques and materials	Climatic considerations: High = 3; Moderate = 2; Low = 3 Climatic considerations: High = 3; Moderate = 2; Low = 3 Climatic considerations: High = 3; Moderate = 2; Low = 3 Climatic considerations: High = 3; Moderate = 2; Low = 3
7.	**Green urbanism**	Accessible open spaces Impervious surfaces Common public spaces for informal discussion	High = 3; Medium = 2; Low = 1 Low = 3; Medium = 2; High = 1 High = 3; Medium = 2; Low = 1

Table 1 presents a summary of the parameters and the evaluation levels.

3.0 Results and discussions

3.1 The walled city of Jaipur

The old walled city of Jaipur was planned in 1727 A.D is one of the important examples of living heritage city of India. It is also considered as the oldest planned city of India. It was founded by Sawai Jai Singh to transfer the Capital of the Kachhwahas from Amber. The foundation of Jaipur is believed to be the outcome of some economic dimensions. When capital was shifted from Dausa and Amber to Jaipur, there recorded a significant economic shift from an agrarian base to trading. (Vrushali et al. 2017, p.141) The foundation of Jaipur was not spontaneous, but it was a planned one, the king was influenced by astronomy and also had a knowledge about architecture, so he decided to plan his city by amalgamating two of the concepts so he invited famous Bengali architect Vidhyadhar Bhattacharya to prepare a plan of the city. Vidhyadhar laid down the plans according to ancient Indian planning principles on architecture called 'Shilpa Shastra' (Vastu), and construction of the city was done in many successive stages, and plans were prepared for the planning the city and its environment. Jaipur is considered by

many urbanists to be one of the best planned cities (Vrushali et al. 2017, p.141). The city was planned in a gridiron pattern, which has been one of the significant principles used from ancient time in the history of settlement planning right from Mohenjo-Daro and Olinthus in Greece to the medieval cities. Sensitivity towards natural context and natural resources was the major driving principles to guide the urban form that can be seen in the city of Jaipur as well

A structure of relative wholeness is observed in the planning of the city of Jaipur. The city was encircled by the city wall and entry was through seven gates i.e., Gate on the Western end, the direction of sunset is called the Chandpol Gate and the opposite Eastern end is called the Surajpol Gate, rest were Ghat Gate, Ajmeri Gate, Sanganeri Gate, Surajpol Gate, Gangapol Gate, Zorawar Singh Gate, and New Gate. Then the inner grid system had wide straight avenues, roads, streets / lanes and uniform rows of shops on either side of the main bazaars, all arranged in nine rectangular (Paramasiya Mandala) city sectors (chokries) thus making the large city wards. To harmonise with the existing natural features, these nine square grids were laid with the cardinal axis. The distance between the ridgeline and the Agra-Ajmer road evolved the size of the quadrants. Due to the presence of a hill on the north-west side of the site, the ninth square grid could not fit in, so it was added to the south-east end of the plan as an adjustment.
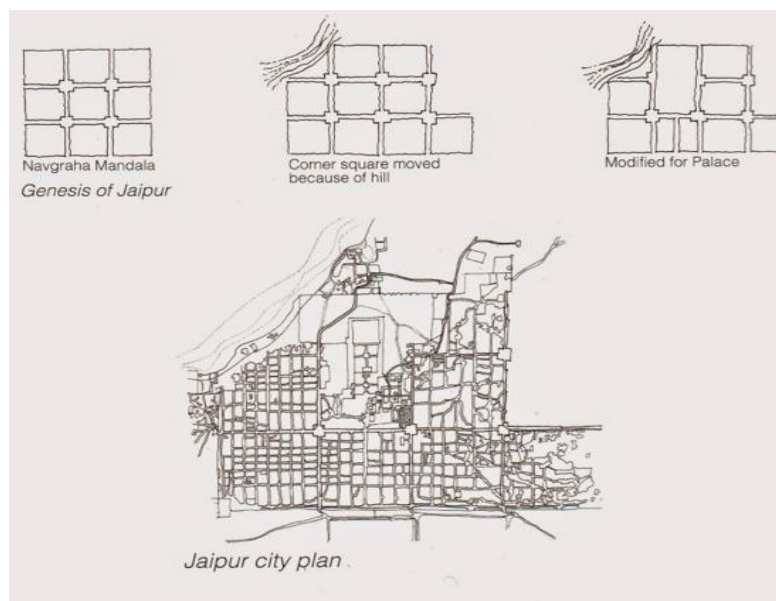

Figure 2 : Plan of Jaipur *(Source: Hidden Architecture, 2015)*

The city planning extended to the socio-cultural domains, which is what is reflected in the eight residential Chowkris (blocks) for the ease of administration. These residential neighbourhoods were demarcated by the main market streets namely: Kishanpole Bazaar, Chaura Rasta, Jauhari Bazaar, Chandpole Bazaar,Tripolia Bazaar, Gangauri Bazaar and Sireh Deori Bazaar .Each cluster had a hierarchical placement of dwelling units with the Havelis or houses of the courtiers, and/ or merchants lining the first layer of the bazaars regularly punctuated by temples approached by a staircase flanked by shops. These market streets were connected with the interior neighbourhood through subsidiary streets called *Raastas*, named after the associated trade or some important person or community residing in the same vicinity. For example, *Maniharon ka Rasta* in Chowkri Modi khana (Jain community), which is primarily meant for lacquers. Likewise, there are some twenty five to thirty arts and crafts of Jaipur, which were systematically manifested in the built form and is thriving till today.(Tillotson, 2004)

The primary roads divide the city into nine chowkries (quadrants), the central two are occupied by the palace complex and tank. The chowkries were further demarcated to public and the king i.e. seven were given to public and two consisted of palaces and state buildings. These were then divided into neighbourhoods made up of cluster of houses that led to individual houses. The buildings were designed as a set of rooms around a courtyard, which was the center of all activities. Thus, the whole city was designed in terms of 'cells within a set of cells' (Vrushali et al. 2017). The organisation of roads and open spaces made all individuals units linked to the bigger entirety. This associated spatial organisation was because of the Vastu rule that it is fundamental to keep up progressive system of roads and open spaces in agreement to how the supreme creator has made the universe where everything is associated with each other (Vrushali et al. 2017, p.141).

The block size study reveals that the prevailing block size in the oldest portion of Jaipur, including Purani Basti, Topkhanadesh, Modikhana, Visheshvarji, ranges between 200 m and 600 m. It shows the city core's convenient walkability. But the urban grain shifts to a great degree as one pass through Ghat Darwaja, Ramchandra Colony and Topkhanahazuri which are assumed to be a later addition. When one can see wide and circular blocks, these areas become less permeable.
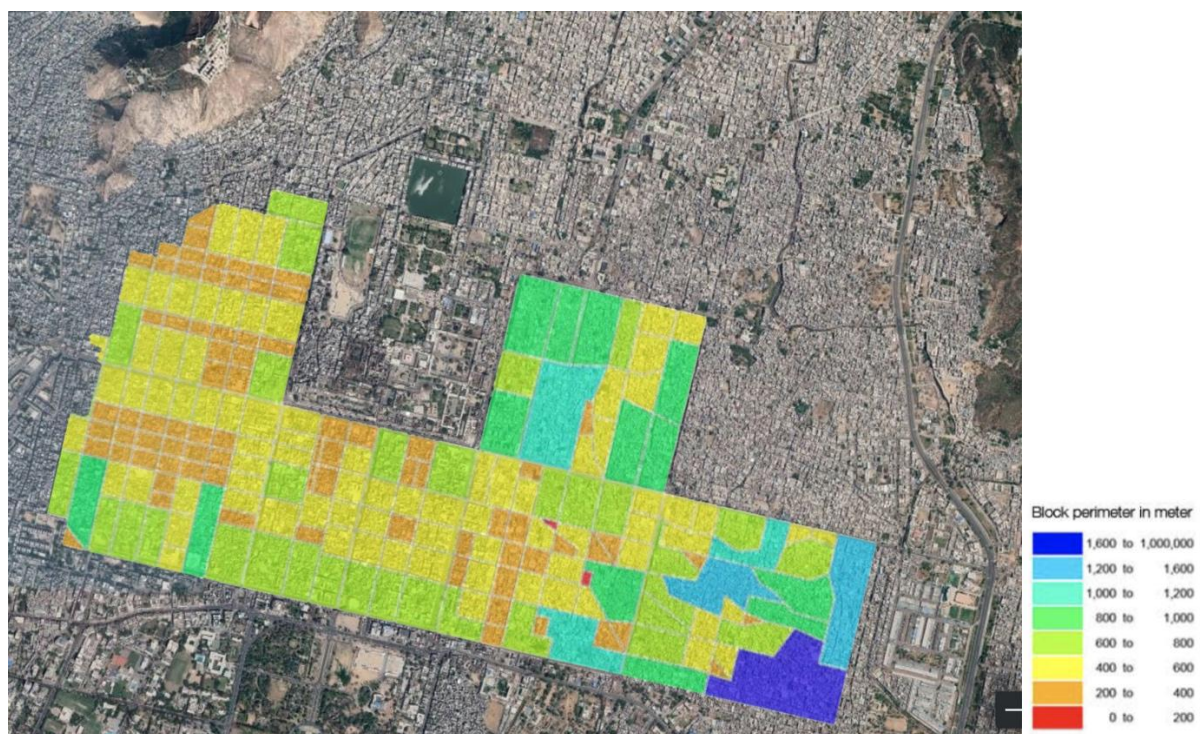

Figure 3: Block analysis of Jaipur

In Rajasthan, where the climate is largely hot and arid, it evolves into an introvert-built fabric using stone as the major source of building material. The courtyard type of house or Haveli as the name perhaps originating from Hava or wind utilises the air movement generated by convection due to high temperature to reduce the discomfort. Here the Vastu Purusha Mandala is perceived as a pattern of squares in which the central squares are ruled by Brahma. These central squares form the courtyard around which are built the rooms opening inwards, inhaling cooled air. The walls are usually 2ft. or more in thickness, stone-clad over brick and lime masonry, and so generate a time lag in the process of conduction of heat. As a result, in the daytime, the thick walls and roof prevents the

sun's rays from heating the interior. By the early morning hours, when the outside temperature drops unbearably low, the heat stored in the thick walls is discharged by reradiation, making the interior thermally comfortable. The compact built fabric further helps by keeping the common shared walls cool. Apart from working as a lung for the house, the courtyard is a semiprivate open space that is used extensively for various household activities. This control is dictated by the Vastu Purusha Mandala. The maximum spanning limit of the stone slab, or more generally speaking, the constraints presented by the characteristics of the building materials could be suggested as one of the factors that control the proportions of the Haveli. This means that the size of the room is determined by the slab, and since the ratio of the built and open space is dictated by the Vastu Purusha Mandala, it could be inferred that the norms are controlled by, or more correctly, adapting themselves to, the regional peculiarities.
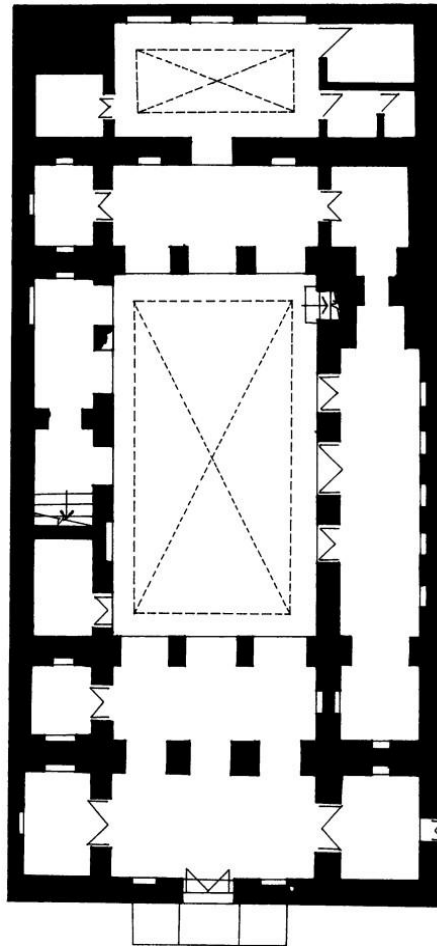

Figure 4: Typical layout of a house in Jaipur following Vastu principles (Source Shukla, D.N 'Vastu Shastra, Vol -1, Hindu Science of Architecture)

The organisation of residential units in a quarter at the north-west of Vishesvorji illustrates various forms of *Galli* and their relation to *rasta*. It is seen that the pattern of the division of the residential quarter into residential units by *gallis* is not of the same type but varies according to the needs of the individual units.

Figure 5: Organization of residential units in a quarter at the north-west of Vishesvorji (Source: Google Earth

Evaluation process:

Sample Size:

Through purposeful sampling, 20 architectural students were chosen. There were 14 male and 6 female students, of 2nd year Architecture and Planning,GGSIPU.The students were visiting the walled city of Jaipur as part of the Architectural Education trip and they were asked to evaluate the parameters. The students had stayed in the walled city for a period of seven days and had explored its environs by foot to understand the various parameters. They had interacted with local shopkeepers and residents. In the next step of the study the scale shall be validated by residents of the walled city.

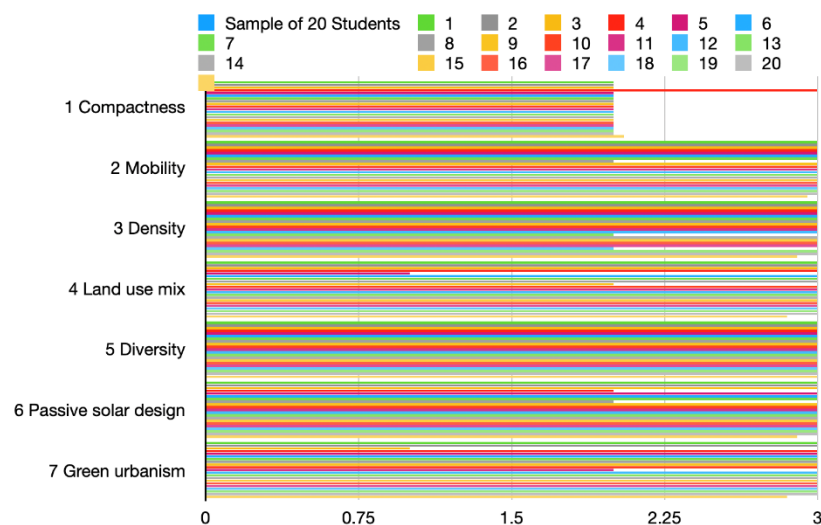The mean score of all the indicators ranged from 2.05 to 3.

Table 2: The evaluated scale of smart urban elements of Jaipur (The score is the average score of 20 students)

S.no.	Smart urban elements	Indicators	Evaluation criteria (The mean/average score by 20 students)	Characteristic Feature
1.	**Compactness**	Dwelling unit density	2.05	Mohallas closely knitted together in the form of clusters leading to compact development pattern
2.	**Mobility**	Home to work distance	2.95	Work in home-based enterprises and 51% in core city area within walkable range with tourism and handicraft related activities. Narrow zigzag streets connect to other mohallas forming a closely connected network. The main arterial roads provide access to important community areas, city palace Street layout organic and irregular street network with excellent connectivity to innermost Mohalla community. Except royal carts and other means of movement along main arterial streets, no provision for vehicular movement is provided within mohallas
		Internal connectivity	2.85	
		External connectivity	2.9	
		Street layout	3	
3.	**Density**	Persons per hectare	2.9	Due to the high concentration of economic activities, the walled city has a very high density of population, exceeding 75,000 inhabitants per square km. (1 Hectare is 0.01 sq. km) Except animal carts and hand-pulled rickshaws means of movement along main arterial streets, no provision for vehicular movement is provided within mohallas.
		Commuter mode choice	2.6	
			2.85	
4.	**Land use mix**	Mixed residential land use	2.85	The main city core is around 5 to 15 min walking distance from various mohallas to the bazaar. Walkability to social services, Common facilities and services shared among residents or more neighbourhoods thereby increasing accessibility of the local community Mixed land use in most of the case, ground floor is used for commercial purposes and top floors are used for storage or go down and residential purposes
		Walkability to city centre	3	
		Walkability to social services	2.75	
		Mix of commercial and residential land uses	3	
5.	**Diversity**	Building typology	2.85	There are numerous intangible heritage and crafts for which Jaipur is famous among tourists. Many people were found to be engaged directly in traditional and cottage industries, there was a time when all classes of people used to stay together in old city area. However, now most of the affluent class has moved out leaving behind poor and socially backward people in the old city area
		Socio-cultural mix	2.75	
		Local creative economy	2.75	
		Income groups	2.9	
6.	**Passive solar design**	Orientation and Siting	2.85	Houses have been oriented and sited to avoid direct sun rays in habitable rooms and facilitating mutual shading on streets Building layout Multifunctional courtyard type planning is quite common with rooms surrounding it. Family uses
		Building layout	3	
		Facade and fenestration	2.85	

		Building techniques and materials	2.05	this space for several purposes such as sleeping, grinding spices, making pickles and making pottery or other craft-based industries. Jalis (Screens) and Jharokhas (Balconies) are used as architectural elements to ensure cool breeze within the interiors and also to avoid heavy dust storms. Building techniques and materials Stonemasonry and lime mortar is commonly used with intricate carvings and thick walls with more time lag is common.
7.	**Green urbanism**	Accessible open spaces	2.95	Chowks or squares with wells, tanks and trees as congregational places with sitting affordances in local mohallas. Impervious surfaces: Less in number except forming arterial roads. There have been no major drainage issues in old settlements. Rainwater gets collected in wells and step wells for use in summers. Common public spaces for informal discussion. Chowks were used as places for local gathering, celebrations, rituals and high level engagement and dialogues among its local public time.
		Impervious surfaces	2.85	
		Common public spaces for informal discussion	2.9	

3.2 Key Inferences:

The case study was carried out for the walled city of Jaipur in the Indian subcontinent are subjected to tremendous pressures of urban expansion. The city is based on smart urban planning principles, which are the core essence of Vastu Shastra philosophy. These principles evolved because of social, economic, geographical and religious paradigms of native communities over a span of time. The archetypes represent various urban elements which are smart and inclusive in nature and are at par with the modern and contemporary city planning approach.

1. The city of Jaipur perform well in the present urban sense, unlike many ancient cities in the world. These spatial systems have sustained multiple societal, social and economic transitions without losing significance. And this shows that these age-old planning are robust and resilient. Compact settlement pattern with narrow streets with tall buildings helps in reducing the heat gain, ensuring round the day usage of space.

2. The urban blocks—chowkri, formed by the main streets are not of uniform size. However, the three chaupars are of the same size (350 ft square); thus, their present form derives from the planned execution of that period. It is not yet clear whether the ideal planning concept of 3 x 3 = 9 square has been employed in Jaipur, but the importance of the east-west central street is clear. This street was a long-established route from olden times and runs parallel to the ridge of the hill at the north. In addition, the fact that it is an axis to the Suraj temple in the east must have led to the east-west street as the first factor in making the planning decision.

3. Irregularities in the street pattern become more apparent as one goes farther from the centre towards the periphery of the city. The quarters with irregular street pattern coincide with the distribution of the mosques. This might have been due to the influence on the settlements by the Muslim communities.

4. Influence of small blocks on smart cities: Urban block size analysis illustrates, majority of urban blocks in the historic core of Jaipur have perimeters ranging from 200m to 600m. Similar dimensions can also

be found in western urban design standard which suggests blocks of 60-90m X 90-120m provide the optimum dimensions to support good pedestrian accessibility (Yeang, 2007, p.65)

   a. Small blocks lead to close-knit social fabric
   b. Less carbon footprint
   c. Promotes walkability, and hence the mobility is more sustainable.
   d. Neighbourhoods in both the cities have long walls and entry gates for selective accessibility, which segregates the entry of pedestrian and vehicular movement at various time of the day.
   e. The walled city Jaipur both show a high degree of mobility, compactness, density, passive design and green urbanism.
   f. Both the newer and older city of Jaipur had a heterogeneous mix of communities in terms of social as well as economic status. They have their own social hierarchy to be maintained to satisfy their respective cultural needs. All these qualities of social and public space ensures an effective citizen participation and self-governance at the local level. This further encourages people of the community to participate and engage in the development activities of their neighbour-hoods.

5. The walled city of Jaipur has a characteristic compact development with a low rise and a highly dense cluster of neighbourhoods. These old neighbourhood or mohallas are flexible to accommodate the future needs of its community. The basic circulation and transportation planning were sustainable with efficient walkability and accessibility of community to the local city centre and public services. The design and layout of buildings and dwelling units are based on vernacular design techniques well adapted to harsh hot and dry and humid climate of the region. These old settlements also maintained an optimal mix of open spaces in the form of squares, courtyards as well as street corridors for children to play safely and adults to have important discussions and conversations. Chowks or Junctions were crucial meeting places for community discussion and participation. Old wells and tanks employ natural water management techniques. Also, a natural drainage pattern has been observed in the walled city as per the natural contours and the old neighbourhoods seldom face issues of waterlogging.

6. Overall, these traditional settlements show a holistic planning ideology in both cases, which is intuitive and wholesome. Their spiritual values and social belief system guided them to a more sustainable and inclusive society. Environmentally, they used sound building techniques with sensitivity towards local climate and natural resources. Socially, these settlements maintained a diverse mix of people with the least conflict among its communities. Public participation was of the highest order, where local decisions were based on the consensus of its people.

7. Further, these communities of walled city has high potential to harness their local creative economy and intangible heritage. These settlements, which are often termed as obsolete and backward, are found to be more sensitive with creative features leading to cultural continuity. As seen in most of the cases, modern planning stereotypes which have been imposed on these areas without considering their socio-economic and cultural context resulted in the destruction of a sustainable community rather than advancing their inherent local smartness. Their parameters has an implicit smartness quality enhancing the inclusiveness and sustainability of the communities. It is important to make way for their smart planning with new urban technology and ICT solutions. It is important that the urban practitioners and decision-makers don't forget the roots of existing old cities to develop a plan which won't be even people-friendly.

4. Conclusion

This paper has studied the walled city of Jaipur which was planned on the principles described in the traditional architectural treatise called 'Vastu Shastra'. A set of seven parameters have been identified, and an evaluation of the city planning using these parameters has been done by two independent architects. It was observed that the principles as described in the 'Vastu Shastra' seems to have a positive impact on the development and growth of the city. Based on the findings of this paper, it is argues that the development act of any city should take into account the unique characteristics of each region. The approach towards planning will have to take into consideration the regional characteristics, climatic conditions, lifestyle of people, local crafts and the various traditional methods of planning. Development Acts should incorporate the relevant principles of our traditional/ ancient planning principles as enunciated in Vastu Shastra. When the government sets up a committee to amend the development acts, the term of reference of such committees should include examination and incorporation of relevant aspects of Vastu Shastra in the master plan of the upcoming smart cities. Apart from quantitatively analysing the structure of Jaipur, this study also opened up possibilities for further researches. Not many studies have been done to determine the benchmark for walkable urban environment in India. The block size analysis of Jaipur could be a good starting point to review and compare existing standards with historic city cores that are performing well even today.

Further, some of the important points of this study which has captured the potential of designing walkable cities. A walkable city has a multitude of benefits. The study demonstrates the significant social, environmental, economic, and political benefits of walking thus impacting the overall quality of Urban life and highlights the opportunities available for cities to embrace walking.

1. **Social benefits:** The health benefits of walking are perhaps the clearest, including reducing the likelihood of obesity and chronic disease, as well as improving mental health and happiness. Walking also provides other social benefits, including an opportunity to foster social interaction, reduce crime, and strengthen community identity.
2. **Environmental benefits:** Walking provides an active means for people to mitigate and address local and global environmental concerns. From noise and air pollution to heat island effect, a shift from car-dominated design to pedestrian walkability mitigates a range of environmental concerns. Pedestrian-focused design also allows reclamation of underused road space. Space previously reserved for cars can be shifted towards green space that better addresses community needs, provides wildlife habitat, and functions as stormwater management.
3. **Economic benefits:** Businesses and property owners can also benefit from more walkable places, Walkability has been proven to boost prosperity, support local business, promote tourism, and encourage inward investment – attracting investors and private companies that in turn feeds higher employment, property values, and more .
4. **Political benefits:** Walking is increasingly a political agenda item as cities fight to reduce car congestion and pollution while striving for a safer, healthier, more vibrant community of residents and visitors. Promoting walkability addresses sustainable development and city resilience to climate change, while also encouraging inclusiveness and equality.

5. Future work

Aall the identified urban parameters will to be mapped on Arc GIS desktop version 10.1 and figure-ground
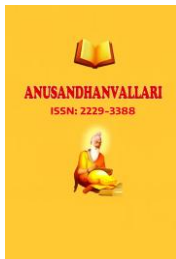
analysis is required to back up the satellite image study. Further in the primary study, around 160 households and 50 local shopkeepers have been identified in the walled city of Jaipur and need to be surveyed based on the structured questionnaire to identify various development trend , local perception and beliefs for assessing the qualitative aspect of quality of living.Stratified random and clustered sampling survey technique shall be used for primary surveys of local residents and shopkeepers. For the purpose of sample size calculation, assuming a normal distribution with the confidence interval of 90%, is proposed to be used (Dhingra et al., 2016).

$$n = z_2 \times p\,(1-p)/m_2$$

where
n = required sample
z = value of confidence level C.L. (for 90% it is 1.645)
p = estimated prevalence of variable of interest
(assumed to be 30%)
m = margin of error (assumed to be 20%)

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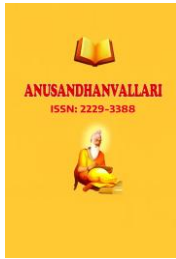
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