

Accessibility and Visibility through Space Syntax Analysis of the Linga Raj Temple in Odisha, India

S. Pramanik

Abstract—Since the early ages, the Hindu temples have been interpreted through various *Vedic* philosophies. These temples are visited by pilgrims which demonstrate the rituals and religious belief of communities, reflecting a variety of actions and behaviors. *Darsana*- a direct seeing, is a part of the pilgrimage activity. During the process of *Darsana*, a devotee is prepared for entry in the temple to realize the cognizing Truth culminating in visualizing the idol of God, placed at the *Garbhagriha* (sanctum sanctorum). For this, the pilgrim must pass through a sequential arrangement of spaces. During the process of progress, the pilgrims visualize the spaces differently from various points of views. The viewpoints create a variety of spatial patterns in the minds of pilgrims coherent to the Hindu philosophies. The space organization and its order are perceived by various techniques of spatial analysis. A temple, as examples of *Kalinga* stylistic variations, has been chosen for the study. This paper intends to demonstrate some visual patterns generated during the process of *Darsana* (visibility) and its accessibility by Point Isovist Studies and Visibility Graph Analysis from the entrance (*Simha Dwara*) to The Sanctum sanctorum (*Garbhagriha*).

Keywords—Hindu Temple Architecture, Point Isovist, space syntax analysis, visibility graph analysis.

I. INTRODUCTION

THE Hindu temple has long been the subject of significant architectural scholarship. Many books, by scholars such as Stella Kramrisch, Dr. Bruno Dagens, Alice Boner, Ananda Coomaraswamy and Dr. Hendrik Kern have focused on temples as sacred objects, elaborating on their formal and stylistic canons. Other books by Michael Meister, Madhusudan Dhaky, George Michell and Adam Hardy, have documented historic temples insignificant detail, attempting to untangle the relationship of the temple's architectural form and its inherent meaning and derivation. They have studied and identified various aspects related to the architectural language of the temple, articulating its formal underpinnings in a compelling, practical and graphical manner [1]. General functions of these buildings are to perform the routine of 'rituals and offerings' in the various spaces within the temple. The temple's spatial organization, thus, was not only for architectural interpretations but also for understanding the culmination of various Hindu philosophies. Movement in architecture can be about how people traverse through space, about how the eye moves over them, or about visual forces... it can be about how architectural forms represent movement or even seem to move [2, p.23]. The pattern of movement, then,

S. Pramanik is with the National Institute of Technology Raipur, in Department of Architecture as Assistant Professor, Raipur-492010, Chhattisgarh, India (phone: +91-8820088999; e-mail: spramanik.arch@nitrr.ac.in).

is an animation of the basic axial organization of the temple. The *Garbhagriha* is reached with a sense of movement which seems to convert from the horizontal axis to the vertical axis reaching the tip of the finial [2, pp.37-38].

As per Hardy, "The architecture must, on one level, be viewed and appreciated for the balance and repose of its static composition; but it also has a temporal structure, of which a given spatial arrangement is a momentary glimpse, or rather, a succession of such glimpses. A series of elements, or of configurations of elements, can be sensed not so much as a chain of separate entities, but as the same thing seen several times, at different stages, evolving, evoking and proliferating" [2, p.39].

The great Linga Raj temple, situated at the Eastern state of Odisha, India is in *Kalinga* style of architecture and is acclaimed as the finest example of Hindu temple architecture in Eastern India built in around 1000 A.D. The temple has all the four parts of the great Odishan temples, namely, *Garbhagriha*, *Jagamohana*, *Nat-mandir*, *Bhoga-mandapa* arranged in one axial alignment as prescribed in the canonical texts.

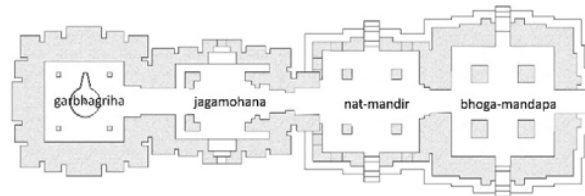


Fig. 1 Different parts of Linga Raj temple [3] modified

Some previous studies on Linga Raj Temple have focused on the compositional type, geometric patterns, symbolism, and aesthetic descriptions, like figures and sculptures on the facades, as different architectural characteristics of the temples [4]. These analyses are based on various classification or comparison of the architectural form with its decoration. The descriptions about the temples and philosophies related to it are often beneficial for understanding their evolution. Demonstrating the spatial laws and visibility and generating various studies of interaction related to it can help in understanding the spaces and their significance for various rituals and activities. The structural components with their specific placement, result in different visual patterns and types of inter-visibility only experienced but might not be quantified or examined.

This paper attempts some of these visual patterns experienced by the devotees and pilgrims during their

darsana. A study can be obtained for visibility and use by pilgrims by their experience through various parts of the temple: *Garbhagriha*, *Jagamohana*, *Nat-mandir*, *Bhogamandapa*. Few points of view are chosen to analyze the visual pattern called isovist and the temple's spacio-ritualistic relations can be calculated by Visibility Graph Analysis (VGA) demonstrated by Turner [5]. Isovist is set of points visible from a defined viewpoint. VGA helps in computing isovist for viewpoints spread across the entire area, so as to map the extent of spaces which are visually 'integrated' (visible from multiple viewpoints) or 'segregated' (visible from few viewpoints) [6]-[8].

After the VGA analysis, the characteristic of spatial patterns during the ritualistic activities are studied for the temple. It briefly postulates a generative theory which interprets the philosophy incorporated in the temple's spatial structure and order [9].

The chief characteristics of the East Indian temples lie in their plan and elevation. In the interior, the shrine is always square, but on the outside projections adorn each of the four sides creating facets of vertical offset projections as *Ratha*. Although all these projections alter the outer face of the

sanctuary entirely, the form and position of the inner cella and the place of the door do not change. However, it is not so conspicuous, because the portal of the *garbhagriha* opens into the *Antarala* (vestibule) and the assembly hall attached to it [4, p. 4].

The pilgrims visiting the temple and their visual experience in viewing the rituals involve two factors, on one side identifying and seeing the architectural space and elements, on the other hand co-relating them to the philosophical experience within those spatial relationships. Both these processes are important to understand the temple *darsana*. As described by Hillier about spatial analysis:

“Starts with the object and examines it for evidence of order resulting from human behavior. It (space syntax analysis) therefore makes no assumptions about human behavior but looks for evidence of human behavior in the object. Space syntax also studies human behavior. To see how far evidence can be found in their distributions of influence of the object. In both senses, Space syntax seeks integration of the human and the physical by seeking evidence of each in the form of the other” [10].

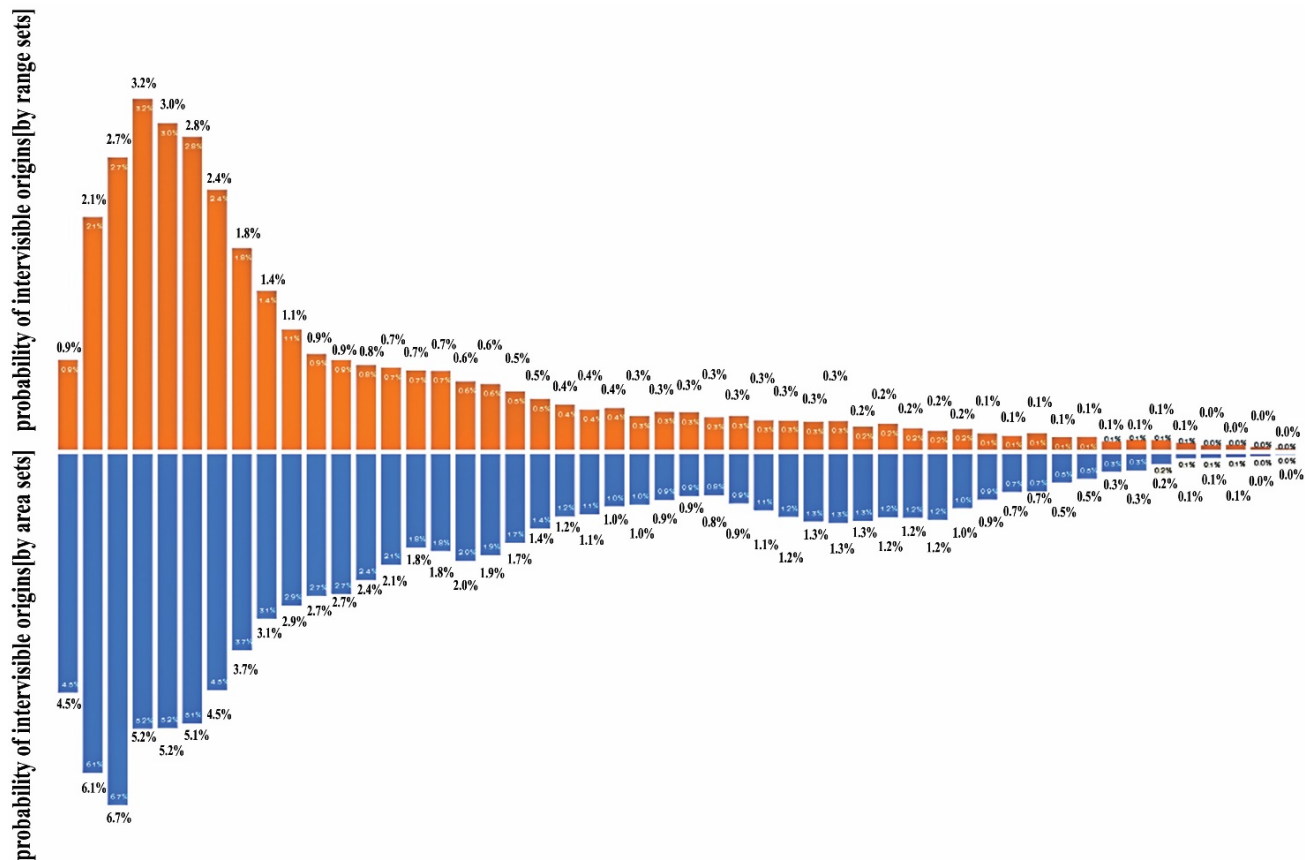


Fig. 2 Probability of Intervisible regions and origins for Linga Raj temple

The temples were developed to perform the rituals and restore faith and providing a path of practice for the people.

The *sthapaka* (architect - priest) consciously build the temples to reflect the philosophies through rituals and various

ceremonies performed in the temple structure at certain designated spaces. The rituals and *darsana* performed within the temple created dynamism and active spaces through the function of intervisibility (Fig. 2) and movement patterns of the pilgrims following the spatial laws which could be identified. The paper analyzes these patterns of movements, visibility and accessibility inside the temple spaces as experienced by the pilgrims.

II. A VISUAL EXPERIMENT

The understanding of the effects of lighting in Hindu temples is to create mysticism where the sanctum sanctorum (*garbhagriha*) is usually placed in the dark. The study conducted has not been through the emphasis on lighting and its effects. So, studying the direct and indirect lighting obtained through oil lamps can impact on the visibility and can be understood through the experimental model from Franz and Wiener [8]. So, a parameter could be generated to estimate the experience by a pilgrim from the entry point of *Simha-dwara*, then in the *Bhoga-mandapa* in relation to a pilgrim at the *Antarala* of *garbhagriha*. An experimental model was generated based on the early theory for proximetrics introduced by Hillier [10] and also used by Searle and Lukken [11] in their semiotics studies.

III. ISOVIST AND VGA

The temple, due to its structural configuration, generates an axis. The spatial techniques to analyze visibility has been applied which gives clarity of the patterns of spatial composition.

An Isovist means “the area in a spatial environment directly visible from a location within the space” [8]. Early studies on Isovist, by Benedikt in 1979 [12], tried to use local measurements which quantified the spatial environment and perception of visibility generated from a single viewpoint. Advancement in the studies has been achieved through VGA. This is analyzed using the principles based on graph theory. These techniques can help refine our scale in two different ways. Firstly, “to describe a configuration with reference to accessibility and visibility, to compare from location to location within a system” and secondly “to compare systems with different geometries” [8]. Through this one can understand the perceptions, ‘the lineal and axial properties’ of our temple at the human scale. One can analyze the visual relationships to the philosophy of temple development as one moves from point to point within the temple towards the *Garbhagriha*. This implies the perceptions one might have while standing at the *Bhoga-mandapa*, *Nat-mandir*, *Jagamohana* or *Antarala*, or from the most integrated viewpoint in the *Nat-mandir*.

Research by Franz and Wiener’s [6] for spatial cognition highlights the tensions between phenomenology and social physics [13]. It generates quantifiable relationships through isovists to understand human experience and behavioral pattern. The characteristics of spaciousness, openness and, complexity has been achieved through isovist analysis of the

temple from the positions of *Simha Dwara*, *Bhoga-mandapa*, *Nat-mandir*, *Jagamohana* and *Antarala*, at their transition and at the center of the spaces.

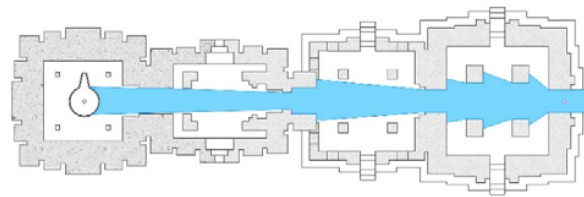


Fig. 3 (a) At *Simha Dwara*

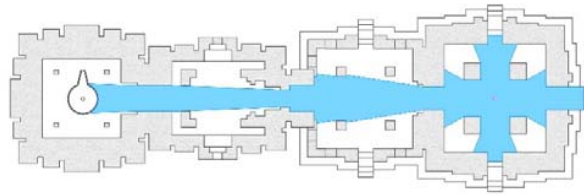


Fig. 3 (b) At center of *Bhoga-mandapa*

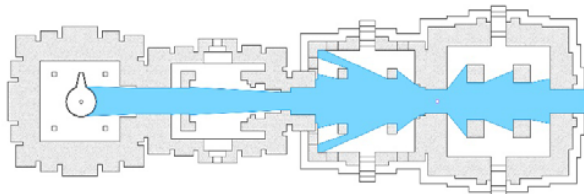


Fig. 3 (c) At transition space between *Bhoga-mandapa* and *Nat-mandir*

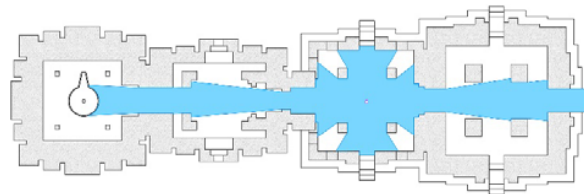


Fig. 3 (d) At center of *Nat-mandir*

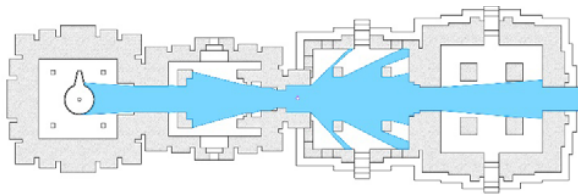


Fig. 3 (e) At transition space between *Nat-mandir* and *Jagamohana*

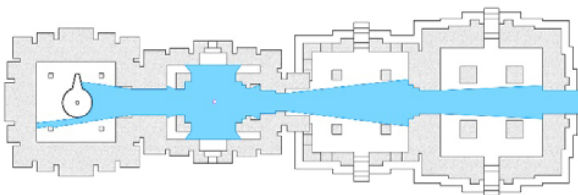


Fig. 3 (f) At center of *Jagamohana*

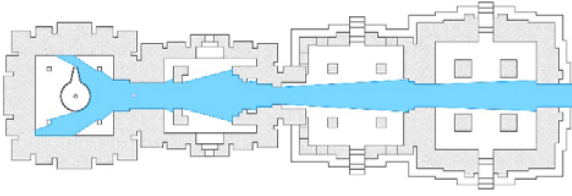


Fig. 3 (g) At Antarala

IV. SPACIOUSNESS

It is measured through the isovist's metric area. Space with its dimension creates an impact on the viewer. As clarified by Franz and Wiener [6], the visitor experiences the compulsive response to space, i.e. generating the sense of claustrophobia or agoraphobia, to admit the reality of the impact of spaciousness and its effects on humans [14]. Within the temple space, the pilgrims often relate to their local positions inside the temple. The isovist of the person moving through the spaces inside the temple has a different experience as observed in Figs. 3 showing the space of *Nat-mandir* as the most spacious. The *Nat-mandir* is dedicated for dancing as a ritual of dedicating it to God and hence is most spacious.

V. OPENNESS

Openness is achieved by the formula 'Isovist perimeter²/area', which can generate a psychological response in mind about the elements which are more prospective or refusing by nature. 'Defensible space theory' [15] suggests a one-directional preference, resulting in a pattern, preferential to an axis, from the *Simha dwara* to *Garbhagriha*, along the movement path of the pilgrims. A forward-looking vista is generated where the clear visibility is shown in Fig. 4, though it is not much connected with the visual obstructions by other pilgrims or outside the peripheral vision of pilgrim.

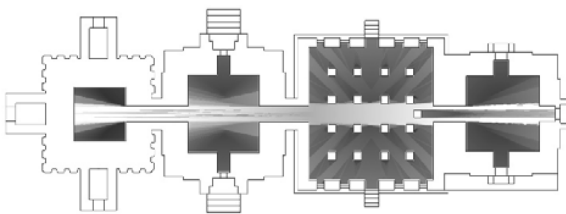


Fig. 4 Vistas for Linga Raj temple

All viewpoints and their relationships to various other points in the view are obtained by VGA, generating a non-preferential and global perspective. There seem to be having a pattern of movement in the temple where vistas created at the *Simha Dwara* and *Antarala* is most streamlined. As shown in Fig. 4, it provides a clear conception of movement and dynamism achieved during the *Darsana*, where it is more focused at the *antarala* and the entrance. Table I shows ranking of the spaces in terms of openness. At transition, space between *Bhoga-mandapa* and *Nat-mandir* the openness is most perceived by the pilgrims.

TABLE I
OPENNESS (ISOVIST PERIMETER²/AREA)

Various positions	Ranking	Openness
At <i>Simha Dwara</i>	3	0.0016020123
At center of <i>Bhoga-mandapa</i>	2	0.0016039408
At transition space between <i>Bhoga-mandapa</i> and <i>Nat-mandir</i>	1	0.0016057254
At center of <i>Nat-mandir</i>	4	0.0015991292
At transition space between <i>Nat-mandir</i> and <i>Jagamohana</i>	7	0.0013805036
At center of <i>Jagamohana</i>	6	0.0014678181
At <i>Antarala</i>	5	0.0014958226

VI. COMPLEXITY

The parameter of complexity is achieved by 'variety and richness' and unpredicted, random patterns of visual movements creating a chaotic perception. Though the axis of the structure of the temple might generate an order of vision, creating vista, the columns placed in the space would interrupt the maximum possible views. From the isovist illustrations of the various points (Fig. 3), the outlines of unhindered isovists from each of these points are seen. An experiment generating sensitivity to compare the isovists was also performed. This study was conducted by keeping in mind that VGA has benefit for presenting an isovist which is obtained by the humanistic scale and interactive to all other points inside the visual graph from a single person's perspective. Applying the formula by Franz and Wiener [6] for spaciousness, openness and complexity, also taking out and ranking the numerical values of the isovists, generates significant pattern as shown in Table II. The pattern for complexity (area/isovist perimeter²) is observed at the transition space between *Nat-mandir* and *Jagamohana* in contrast to the space in *Nat-mandir* itself, reflecting the movement of pilgrims towards the *Garba griha* and for the pilgrims moving out of the sanctum through *Jagamohana*.

TABLE II
COMPLEXITY (AREA/ISOVIST PERIMETER²)

Various positions	Ranking	Complexity
At <i>Simha Dwara</i>	5	624.215
At center of <i>Bhoga-mandapa</i>	6	623.464
At transition space between <i>Bhoga-mandapa</i> and <i>Nat-mandir</i>	7	622.771
At center of <i>Nat-mandir</i>	4	625.340
At transition space between <i>Nat-mandir</i> and <i>Jagamohana</i>	1	724.373
At center of <i>Jagamohana</i>	2	681.283
At <i>Antarala</i>	3	668.528

The linear shape, with the columns interspersed, the visual complexity of the assembly is more understood in Fig. 5, where the radial viewing angle is perceived more through the analysis. The *Jagamohana* is the most spread out from the center in terms of its visibility with the least number of columns within this space.

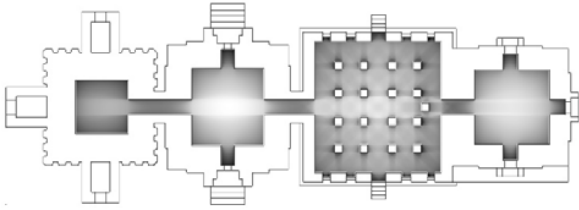


Fig. 5 Radial Average for Linga Raj temple

[15] O. Newman, *Creating Defensible Space*, DIANE Publishing, 1966.

VII. CONCLUSION

It is observed that as one proceeds from *Simha dwara* to *Garbhagriha* the openness and spaciousness reduces sequentially, thus making the spaces more confined at restricted. It is also observed that the transition space between *Nat-mandir* and *Jagamohana* is the most complex space in terms of visibility. The radial average denotes, *Jagamohana* as the most spread out space in the order. All these enhance the linear movement of the pilgrims towards the deity and generate the feeling of retracing the path of creation from form to formlessness.

ACKNOWLEDGMENT

The author would like to thank National Institute of Technology Raipur, Raipur for providing the opportunity to present the paper. He gives special thanks and regards to Dr. Abir Bandyopadhyay for providing insight about the topic and his guidance that greatly helped in writing the paper. He would also like to thank Pritam Panja, Shashwati Khawale, Himanshu Sonber, Vivek Agnihotri and Shashwat Sarangi for assisting him by furnishing information for this paper.

REFERENCES

- [1] V. Bharne and K. Krusche, *Rediscovering the Hindu Temple: The Sacred Architecture and Urbanism of India*. Cambridge Scholars Publishing, 2014., pp. 04-05
- [2] A. Hardy, *The Temple Architecture of India*. Chichester, Wiley, 2007.
- [3] P. Brown, *Indian Architecture, Buddhist and Hindu Periods*, Kiran Book Agency, Delhi, 2010., pp 85
- [4] N. C. Panda and K. M. Suresh, *Temple Architecture of Orissa*, Bharatiya Kala Prakashan, 2014.pp.03
- [5] A. Turner, *Depthmap*, 6.05 edition, London: University college of London.
- [6] G. Franz and J.M. Wiener, *Exploring isovist based correlates of spatial behavior and experience*, 5th International Space Syntax Symposium Proceedings, TU Delft, 2005, pp.503-17.
- [7] A. Turner and A. Penn, *Making isovist syntactic: isovist integration analysis*, 2nd International Symposium on Space Syntax, University de Brasilia, Brazil, 1999, Proceedings, pp.1-9.
- [8] A. Turner, M. Doxa, D. O'Sullivan, A. Penn, *from isovists to visibility graphs: a methodology for the analysis of architectural space*, Environment and Planning B: Planning and Design, pp.103-21.
- [9] B. Hillier and J. Hanson, "The logic of space," *The social logic of space*, Cambridge University press, pp. 52-81.
- [10] B. Hillier, *Between social physics and phenomenology: explorations towards an urban synthesis*, 5th International Space Syntax Symposium Proceedings, TU Delft, pp.3-23.
- [11] M. Searle and G. M. Lukken, *Semiotics and Church Architecture, Liturgia Condenda*, Leuven:Peeters, 1993
- [12] M.L. Benedikt, *To take hold of space: isovists and isovist fields*, Environment and Planning B, pp. 47-65
- [13] B. Hillier, *Space Is the Machine: A Configurational Theory of Architecture*. CreateSpace, 2015.
- [14] E. T. Hall, *The Hidden Dimension*, Leonardo, vol. 6, no. 1. pp. 94.