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# The IIA National Awards for Excellence in Architecture 2023

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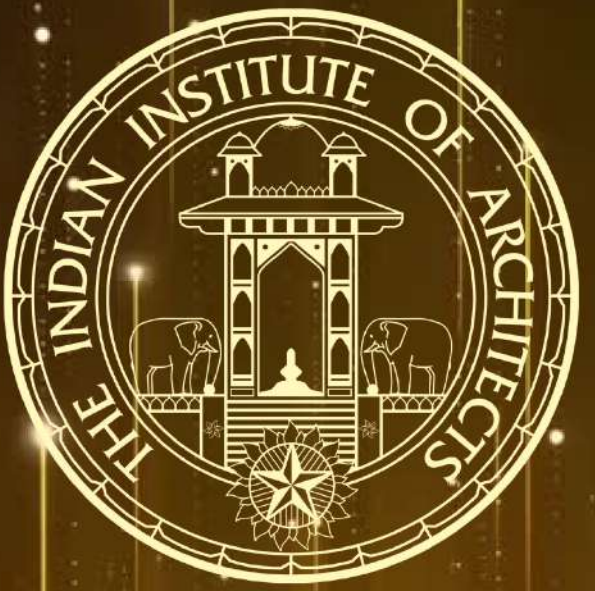

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+91 22 22046972 / 22818491 / 22884805
iiapublication@gmail.com
www.indianinstituteofarchitects.com

**Editor Ar. Lalichan Zacharias**
Kakkamthottil, Jaya Nagar, Marudu P.O., Pachalam S.O., Maradu, Dist-Ernakulam, Kerala-682304.
R.N.I. No.9469/57
lalichanz@gmail.com

Advisors : **Ar. Mukul Goyal**

**Printer's Email**
arihantdigiprint.offset@gmail.com
krish.graph2021@gmail.com

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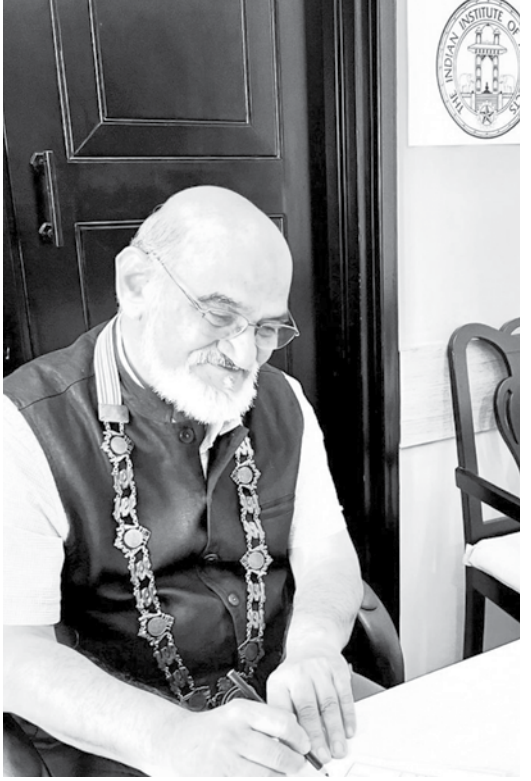
# PRESIDENT'S MESSAGE



Dear Fellow Members,

It's really a great pride to see some architects especially the young are leaving imprints of their architectural practice through their work, enhancing the architectural awareness in the community. We have seen the successful 'YAF', Young Architects Festival at Mamallapuram, hosted by Tamil Nadu chapter, with wonderful presentations by Young Architects & Key Note Speakers who shared great insights of their diverse practices which was delight to delegates attended this festival. They got enriched by the sightseeing of historical monuments present around the well curated venue of this event.

We have upcoming IIA Awards at Rajkot, Gujarat, hosted by IIA Gujarat Chapter on 20th, 21st & 22nd March 2025, followed by 'KEP' Knowledge of Exchange program on 4th & 5th April 2025 at Jodhpur, hosted by Jodhpur Centre of Rajasthan Chapter. This event will be attended by Arcasia President, Vice-President Zone A, along with President of Zone A of Arcasia region. Post this, NTCON is awaited on 10th, 11th, 12th, 13th April 2025 jointly hosted at Bhopal & Indore by MP Chapter of IIA.

While doing all these events, our Architectural Community has come closer both in India & abroad working towards betterment of our fraternity. Soon we will have Special General Body Meeting for Amendments of IIA Bylaws (without disturbing constitution) which is necessary looking at the growth of IIA & also its need of hour.

Warm Regards,

**Ar. Vilas Avachat**
IIA President.

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# EDITOR'S NOTE

Greeting to all the IIA members, from the JIIA Team.

This New Year started with bang where we witnessed great world events, like Trump taking the oath as President of the United States of America, the Ceasefire Declaration on Gaza, Zelenskyy and Trump meeting over Ukraine war – all these have spread some hope as well as apprehension amongst the world's citizens. In India we concluded the biggest ever Mahakumbh on Mahashivratri, held on 26 February 2025, at Prayagraj. This event was visited by 66 crore people from all over the world, which is almost nearing 8% of the world population. Now we have to wait till the year 2169 to witness another such extravaganza on earth.

IIA also witnessed the '*kumbh*' of intellectual deliberations and discussions at the Young Architect Festival (YAF) 2025 curated and organised by IIA Chennai Centre under the aegis of IIA Tamil Nadu Chapter, conducted at the historically significant city of Mamallapuram. This well-conceptualized event, attended by many professionals from all over India, boasted a great line of speakers of national and international repute. Of special importance were the Keynote Addresses- by Ar. João Albuquerque, Partner, *BIG* (Bjarke Ingels Group), on *Hedonistic Sustainability* on the first day of YAF, and on second day - *Digitalisation in Architecture and the Augmentation of Creativity* by Ar. Martha Tsigkari, Senior Partner, Applied R+D, *Foster + Partners*- both of which were simply fabulous and an eye-opener. YAF 2025 was certainly a benchmark of energetic events, participated in by all young professionals and very well acknowledged by the fraternity.

This *kumbh* of events is not stopping here at IIA. We will be witnessing the IIA National Awards on 21 and 22 March 2025 at Rajkot, Gujarat. It is also going to be a captivating event. And we will witness the *mahakumbh* of architects from 11-13 April 2025 in the land of Mahakal, Madhya Pradesh, during NATCON 2025: *Transom,* will be hosted jointly by the Bhopal and Indore Centres of IIA.

We all are grateful for all the Office Bearers' respective Committee Members and other IIA Members who are constantly working to provide such opportunities and to create such platforms of interactions and discourses which will help the fraternity a great deal. It is vital for every IIA member to participate in these events to showcase our leadership in architecture worldwide. I appeal to all the members of IIA to register for these events and participate in large numbers.

An appeal to all IIA members to contribute to JIIA with articles, projects, research papers and most importantly, in terms of sponsorship and funding. Thank you for your continued support and readership.

**Prof. Vinit Mirkar**
Editor





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**COVER THEME**

# Architectural Harmony of the Northern Region
# A Tapestry of Heritage and Unity

The cover of JIIA beautifully encapsulates the architectural splendour of the Northern Region of the Indian Institute of Architects, weaving together a vibrant tapestry of culture, history, and design. At its heart, the serene lake of Jammu & Kashmir mirrors the tranquil beauty of the region, complemented by the intricately crafted wooden houses of Himachal Pradesh, a testament to the hill architecture that has stood resilient for centuries. Towering in the backdrop, the majestic Shivalik Hills of Chandigarh create a sense of grandeur and continuity, connecting the diverse landscapes of the northern states.

The architectural essence of Punjab is represented through its domes and intricately designed structures, along with the arc, vaults and dome reflecting from Haryana, while Uttar Pradesh finds its place with the timeless magnificence of the Taj Mahal, a symbol of eternal beauty. The soaring Qutub Minar of Delhi, standing as an emblem of historic excellence, seamlessly blends with the majestic forts and tombs of Uttarakhand, reflecting the rich past and enduring spirit of the region. These iconic landmarks, with their unique styles and influences, collectively symbolise the harmony and diversity of the Northern Region.

This theme is a tribute to the success of the Northern Region Conference, hosted by the Punjab Chapter in Ludhiana, an event that fostered collaboration, knowledge sharing, and a deep appreciation for the architectural heritage of the region. The cover serves as a celebration of architectural brilliance, uniting tradition with innovation and honouring the creative vision that continues to shape the built environment of Northern India.

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**Ar. Pritpal Singh Ahluwalia**
Chairman, IIA Punjab Chapter
*Email : waliaarchitects@gmail.com*

# JIIA Call
## for Papers, Articles, Projects

The Journal of the Indian Institute of Architects invites original and unpublished contributions from members **ONLY** (academicians, practitioners and students) under the following FIVE categories. Submission in each category is strictly only through the respective google forms.

In order to be accepted for publication, all material sent in these categories should have the following components:

1. MS Word document file with text only. Please do not format it in anyway. The numbered captions for all the images will also be in this document.
2. Folder with all images (minimum 300 dpi), numbered according to the captions given in your text file
3. Photograph of the author/s (minimum 300 dpi).
4. Author biodata – Maximum 50 words.
5. PDF (optional)– showing the intended layout. This pdf should include text and all images, with numbered captions.

**Category 1 : Articles**

*google form link: https://forms.gle/7pDFva1HDH4hfUyj8*

Essays, interviews, articles (1500- 2500 words), book reviews (600 and 750 words), travelogues, sketches and photo-essays in the areas of architecture, planning, urbanism, pedagogy, heritage, technology, ecology, theory and criticism, visual design, practice or any other relevant subject pertaining to the built environment. (Details of the format will be available on the JIIA website).

- For a design project, please include the 'Fact File' with the following details : Project Name, Location, Plot area, Total built up, Structural consultants, Project completion. Also please give the photo captions and credits. Please ensure that the image is referred to within the text. For eg, "As seen in Figure 1…". This is essential for the layout.
- For design projects, plans and sections of the project are desirable along with the photographs.
- Book reviews should be only of books by Indian authors. please include the "Fact File" with the following details: book title, author name, publisher, year of publication, ISBN, language the book is written in, genre (technical/ fiction/ etc.), no of pages, dimensions (in cm), type (Kindle/ paperback/ hardback), available at (amazon.in/ flipkart.com/ others).
- Please send a write-up of about 200-300 words along with sketches and photo-essays.

**Category 2 : Student Work**

*google form link: https://forms.gle/hyhsCoK6QPe6qDJu8*

Summaries of dissertations (2000-3000 words) at the level of B.Arch. & M.Arch., and theses at the Ph.D. level. The Guide for that work will be mentioned as the Co-author. (Format will be available on the JIIA website).

**Category 3 : Contributions from Chapter Correspondents**

*google form link: https://forms.gle/Ru4JBLSHwaYEBTcg7*

(a) *Chapter News:* This includes various interesting activities from the Centres of your Chapters (maxm. 500 words for the news from the *entire* Chapter).

(b) News of conferences by the academic institutes in your respective Chapters.

(c) *Obituaries :* Obituaries of IIA members should consist of the photograph of the departed soul, the dates of birth and death and a short 50-word note.

**Category 4 : Research Papers**

*google form link: https://forms.gle/Z9YWQQMaw843N1eT6*

Research papers (2000-5000 words) in the prescribed format. The research may be based on their ongoing or completed research. (Format is available on the JIIA website). All contributions in this category will be double blind peer-reviewed before being accepted for publication by academic experts of repute.

**Category 5 : Cover Design**

*google form link: https://forms.gle/BSkuE5cApXdy7dX1A*

Students from affiliated colleges are invited to design the cover page theme. This should be a graphic based on some aspect of Indian Knowledge Systems. The submission will include the graphic file (jpeg or corel draw); a theme note (with a title) of about 500 words explaining the concept of the graphic.

Please note that the image you send will be adjusted as per the layout requirements of the JIIA Cover.

**Please note:**

1. All submissions will be accepted only through google forms.
2. Submissions will **NOT** be accepted through email.
3. Any queries to be addressed to : jiiaeditorial@gmail.com.
4. When you correspond with us, please give your email id (that you regularly use) and your cell no. (preferably with WhatsApp).
5. It is compulsory to mention your IIA regn. No. Submissions will **NOT** be accepted from non-members.
6. The review process takes anywhere between 4-6 weeks. Since it may not be possible to respond to all authors who send in their work, we will definitely revert if and when your work is accepted.
7. JIIA does not charge any fees for publication of any professional or academic work.
8. It is understood that submission from an author is an original work, unpublished anywhere else, and that IIA and JIIA are in no way responsible for any matter or dispute arising out of the publication of the same.
9. All authors are requested to refer to further detailed information available on the JIIA website.

RESEARCH PAPER

# Identifying and Selecting the Dimensions and Parameters for the Design of the Co-Working and Co-Living Spaces after the Pandemic World

By Dr. Partha Sarathi Mishra, Ar. Debasis Das and Dr. Abhiroop Das

**Abstract**

The COVID-19 pandemic has had a significant impact on the way we live and work. Many people have been forced to work from home, leading to a new demand for co-working and co-living spaces. These spaces provide a shared environment where individuals can work, live and socialise. The Delphi and AHP methods are two qualitative decision-making techniques that can be utilised in designing co-working and co-living spaces. The Delphi method involves gathering and synthesising expert opinions through structured communications. The AHP method, on the other hand, is a multi-criteria decision-making approach used to rank alternatives based on specific criteria. In this study, the Delphi and AHP methods were employed to identify and select the dimensions and parameters for designing co-working and co-living spaces in a post-pandemic world. A panel of experts was assembled to provide their opinions on these parameters and broader dimensions which are crucial in creating co-living and co-working hubs that are now in high demand. The result displays the selected parameters that are relevant for designing co-living and co-working spaces drawn from a set of identified parameters found in the literature and expert opinions.

**Keywords:** Co-Living Spaces, Co-Working Spaces, Delphi Techniques, Analytical Hierarchy Process

## 1. Introduction

COVID-19 has caused a significant shift in traditional work methods across different fields, including medicine (Ehrenberg & Keinonen, 2021) and medical design as well as academics/IT (Rega et al., 2021). Work from Home (WFH) has become a popular option, particularly in the IT industry, as it provides resource management benefits and cost-cutting advantages, but it has also caused professionals to return to their homes in Tier-2 and Tier-3 cities (Corfe, 2019).

According to Rizwana et al. (2020), despite this shift, there are two significant issues: the inadequacy of makeshift home office setups relative to corporate ones and the lack of viable startup ecosystems in smaller cities. These observations point to the need for suitable work environments in Tier-2 and Tier-3 cities that serve multiple functions:

- Setting up resources to support workers in remote locations.
- Conveying amenities for those who face daily commutes.
- Creating adaptable zones for incubation and educational facilities.

The office amenities in co-working spaces include shared desks, private meeting rooms and kitchen facilities. These settings promote creativity through collaboration and provide flexibility for teams collaborating with freelancers or remote workers. Those who use it can access global meeting rooms, shared equipment and common areas (Bouncken et al., 2016).

This idea is complemented by co-living, community living for those who share the same values. These fully furnished spaces, which come with utilities and

cater to different living styles, also foster a sense of community.

Incubation centers provide support to startups during their early stages, such as:

- Technical support (Rizwana et al., 2020)
- Infrastructure (Takawira, 2021)
- Investor access (Martin, 2021)
- Networking opportunities (Zhou et al., 2020)
- Essential business development resources (Corfe, 2019; Mathisen et al., 2012; Udeji, 2022)

This paper will define the design dimensions of a Co-Working Hub that provides an environment conducive to working, learning, and making people together. Key objectives include:

- To devise imaginative workspaces that promote collaboration among experts from various industries.
- To consolidate residential areas with features that promote work-life balance.

Initiating business incubation and skill development through adaptive meeting rooms and smart learning spaces, this comprehensive approach can help both Tier-2 and Tier-3 cities to develop economically while also helping Tier-1 cities become more decentralised.



## 2. Review of Literature

Through exploratory factor analysis and an extensive literature review, this paper has identified various broad dimensions and parameters for co-working and co-living spaces in modern India post-COVID-19. In this research an investigation has been conducted primarily focusing on the basic parameters:

### 2.1 Circulation

Co-living spaces are characterised by circular design, which involves the movement of people and goods within a building. This is emphasised in architecture. The balance between social interaction and visual connectivity is maintained through effective circulation design, which also prioritises privacy and quiet spaces. This factor has a significant impact on the overall quality of co-living spaces.

The four main parameters of circulation design are:

Inclusion in spaces and services is a key consideration, as it ensures that individuals can access them regardless of their abilities. The goal of connectivity is to establish deliberate physical and digital connections that enable movement and communication in any given environment. Safe, efficient movement and social interaction are the hallmarks of pedestrian circulation. Vehicle movement within the transportation network is essential for practical and safe access for vibrant co-living and co-working communities.

Designing circulation spaces that promote community interaction and personal comfort can improve co-living through these parameters. This is a key element in the process. With these considerations in mind, creating functional environments that serve diverse resident needs while also promoting safety and efficiency is key.

### 2.2 Climate

Climate is a key design consideration in co-living spaces, as it directly impacts resident comfort and well-being. Optimal living conditions are created through climate control, which improves indoor air quality and regulates temperature and humidity. Climate-conscious design is based on nine main elements:

Humidity control requires the use of ventilation systems and moisture-resistant materials to ensure occupant comfort. Both natural and artificial light contributes to the health and functionality of spaces while also enhancing the productivity and well-being of occupants. Building placement that optimises energy efficiency and thermal comfort is achieved through orientation. Risky activities include a focus on disaster preparedness and resilience in construction, as well as emergency response. By incorporating natural elements, passive design strives to improve energy efficiency and the quality of an indoor environment. Energy-sparing systems decrease environmental impact and provide a more sustainable operation. The management of indoor air quality requires the implementation of proper ventilation and filtration systems, which have a direct impact on both health and productivity. The use of thermal comfort systems, which include heating, cooling and insulation, results in uniform temperature regulation throughout the space. The wind's direction affects natural ventilation and passive cooling techniques, resulting in improved comfort levels both indoors and outdoors.

Co-living spaces that are not only comfortable but also sustainable and energy efficient can be made possible by incorporating these climate-related factors into the design process. The integrated approach to climate design enables residents to live in harmony with their environmental responsibility while also maintaining the space's sustainability.

### 2.3 Services

In co-living spaces, services are a crucial component of the design, which can enhance liveability, functionality and sustainability. Successful co-living environments are shaped by six key service factors:

The emphasis on acoustics is on keeping the sound in isolation and controlling the reverberation to achieve comfort and concentration. The inclusion of various amenities in the community creates a lively and inclusive atmosphere. Introducing flexibility involves modular and adaptable design elements that facilitate versatility while also encouraging community engagement. Access control systems, surveillance and emergency protocols are all part of the safety and security measures in place to protect residents. Technology is integrated to improve the occupant experience and enhance functionality and connectivity. Sustainability includes addressing the environment through waste management, sustainable transportation practices and environmentally-friendly initiatives.

With a focus on thoughtfully designed co-living spaces, designers can create spaces that serve both practical purposes and also promote community through well-being and sustainability initiatives.

### 2.4 Site and Surroundings

Co-living and co-working spaces are designed so that their functionality, liveability or sustainability are closely tied to the physical location and surrounding environment. A well-crafted site promotes environmental consciousness, social interaction and convenient transportation, recreation, services, etc.

Eleven elements play a crucial role in designing the site and surroundings:

The implementation of bye-laws governs land development, guaranteeing its compatibility with the surrounding environment. The study of contextual analysis involves analysing environmental factors, such as climate, topography and existing structures, to aid design decisions. Drainage systems are responsible for protecting the building and surrounding area from water damage. The space's function and its connection to surrounding properties are influenced by factors related to land use. Legal guidance facilitates the implementation of construction and operational regulations. Neighbourhood influences both use and community integration in this space. The management of noise pollution promotes a peaceful atmosphere for both residents and workers. Entities and development restrictions are determined by site zoning classifications. The site's slope has an impact on the choice of design and construction materials. Foundation design and drainage methods are influenced by soil type. Building techniques are affected by the topography of the terrain.

By thoughtfully considering site and surrounding factors, architects can design co-living and co-working spaces that blend in with their surroundings while also promoting community and productivity. A multifaceted approach ensures the creation of spaces that are both attractive and useful, benefiting residents' well-being and promoting sustainable living.

### 2.5 Sustainability

Designing co-living and co-working space spaces is also important, as they heavily impact the environment. There are nine fundamental elements to consider when implementing sustainable design:

Building materials must be crafted with sustainable materials like wood, bamboo and recycled materials to minimise environmental impact. To improve energy efficiency, facade treatment can incorporate environmentally friendly designs. Rainwater harvesting, composting and recycling systems are examples of environmentally friendly practices. Locally produced materials reduce transportation expenses and environmental impact. The incorporation of natural physical features in lighting and ventilation can enhance energy efficiency. The collection and storage of water for different uses in the space is facilitated by rainwater harvesting systems. Low cost, optimal use of natural light and support for sustainable practices are key to design priorities. Sustainable design should consider cultural elements, such as community gathering places. The preservation of historic building materials and techniques is a concern when renovating historic structures due to historical considerations.

With the right selection of these sustainability elements, designers can design co-living and co-working spaces that minimise environmental impact while still providing optimal comfort for future generations.

### 2.6 Design Elements

Design elements in co-living and co-working spaces fundamentally shape the atmosphere, functionality and user experience. Thirteen key elements guide effective space design:

Aesthetics focuses on creating inviting or energising environments through thoughtful use of colours, textures and materials. Form addresses the layout efficiency and creative expression of spaces. The function ensures the space meets diverse user needs, from sleeping to socialising. Building height

influences the space's scale and atmosphere, balancing between human-scaled and larger environments. Hardscape elements include durable, functional components like floors and walls, while softscape incorporates living elements such as plants and trees to add vitality and texture. Human-made features encompass furniture, artwork and lighting, designed for both functionality and style. Residential complex considerations include access to shared amenities like gyms and laundry facilities. Sensory elements manage lighting, sound and smell to create appropriate atmospheres for different activities. Structural strength ensures user safety through resilient design that withstands environmental forces. Utility planning provides convenient access to essential services like electricity and water. Ventilation systems maintain air quality and comfort through proper circulation. Views connect users with the surrounding environment, promoting well-being and productivity while reducing stress.

By thoughtfully integrating these design elements, spaces can provide functional, comfortable and attractive environments that enhance the co-living and co-working experience. This comprehensive approach ensures that spaces not only meet practical needs but also create engaging environments that support community interaction and individual productivity.



### 2.7 Design Spaces

In a successful co-living and co-working system, the design spaces are key; they facilitate interaction and collaboration among residents. Effective design is dependent on nine primary space types:

Flexible spaces are versatile, accommodating living rooms, dining areas, kitchens and workspaces. Interactive spaces promote community interaction. By blending visual appeal and practicality, thoughtful design creates a sense of balance between negative spaces and positive ones. The preliminary zoning system allocates land to specific uses, intending to optimise space usage. Privacy considerations ensure that individuals can engage in social activities and retreat to private bedrooms, offices or quiet areas. Both public and private spaces are places where people can interact with each other and meet their own needs, fostering solitude and social interaction. Space allocation and overall design influence population density. What is the significance of this? Relaxation and entertainment can be found in recreational areas, which include rooftop terraces that offer panoramic views of the city. Active communities are energised by the dynamic nature of vertical interactive spaces. These design spaces should provide the necessary technology and tools to facilitate flexibility in various activities. By closely considering these factors, designers can create environments that:

- Support community building.
- Enhance collaboration.
- Improve resident well-being.
- Accommodate various activities.
- Establish a balance between social and private necessities.

The careful consideration of space factors can lead designers to develop co-living and co-working spaces that meet the needs of their communities, encouraging them to interact with each other and work productively.

## 3. Methodology

The multi-criteria decision-making process ensures that the design of co-working and co-living spaces is based on a comprehensive evaluation of key design dimensions and parameters.

To select dimensions and parameters for designing co-working and co-living hubs in low-tier cities, a methodology has been developed. This methodology follows a two-step process. The first step involves the Delphi process which allows the selection of the parameters. The second step involves assessing the importance of parameters using expert opinions (Figure 1).

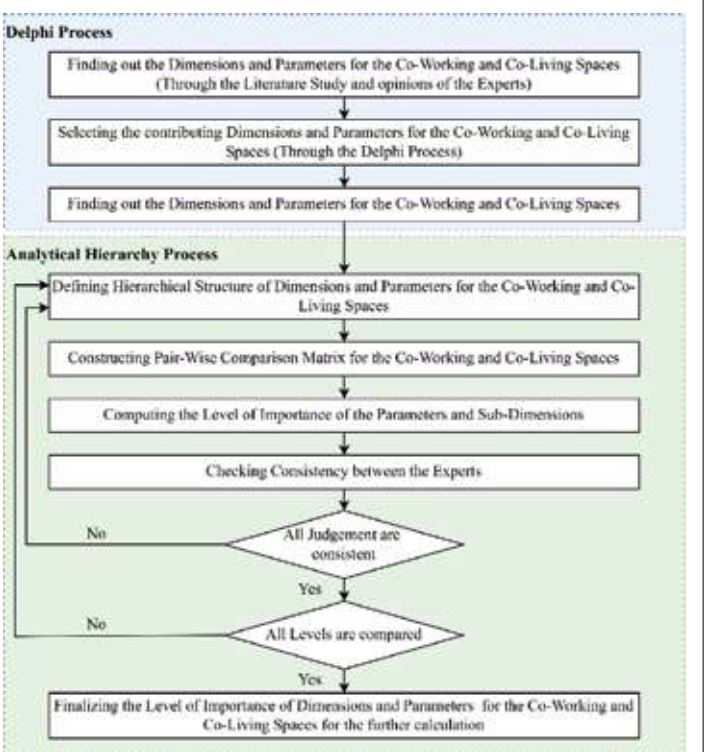


Figure 1: Methodological Framework for Determining the Level of Importance of Dimensions and Parameters in Assessing Co-Working and Co-Living Spaces
*Source: Authors*

### 3.1 The Delphi Process

The Delphi method is a structured communication technique that allows a group of experts to reach a consensus without meeting face-to-face. It is a qualitative forecasting method that uses multiple rounds of questionnaires to gather and refine expert judgments on a specific issue. This process was initially developed by the RAND Corporation to achieve consensus among a group of individuals (Dalkey & Helmer, 1962, 1963). It is commonly used in decision-making processes to identify attributes for evaluation.

As Woudenberg (1991) stated, *"A statistical aggregate of several individual judgments is more accurate than the judgment of a random individual."* The Delphi method is widely to reach a consensus when limited information or evidence is available on a subject (Verhagen et al., 1998).

After determining the parameters and dimensions for studying the co-living and co-working hub, identifying relevant parameters for the assessment process can be challenging. Therefore, the Delphi process was utilised in this study.

According to Linstone et al. (2002), *"In Modified Delphi, the open-ended round of a classical Delphi does not take place. The three main modifications made to replace this Round 1 are as follows: (1) Developing statements from the existing literature in the field, (2) Undertaking focus groups, (3) Undertaking one-to-one interviews."*

The Delphi method can be a valuable tool for identifying the design spaces and parameters that are crucial for co-living and co-working spaces. By utilising this method, it can be ensured that each space meets the needs of its users and provides a comfortable and productive environment.

### 3.2 Analytical Hierarchy Process

The Analytical Hierarchy Process (AHP) is a multi-criteria decision-making method that can be used to rank alternatives based on multiple criteria. It is a structured approach that helps decision-makers break down a complex decision into its parts, identify the important criteria and then rank the alternatives based on those criteria.

AHP is a powerful tool that can be used to make complex decisions. The level of importance of co-living and co-working spaces can be determined and decision-makers can choose using this tool. AHP is an extensively used method for assessing the relative importance of parameters and dimensions. Social researchers frequently utilise this method for pairwise comparisons among parameters and dimensions. AHP was selected for obtaining the weights or relative importance of parameters. The process involves three simple steps: establishing a hierarchy among parameters or dimensions, determining prioritisation among parameters and verifying consistency among experts for consensus. The geometric mean value was used as the final response for each group of experts. A comparison metric for each sub-dimension was created, known as a priority vector matrix, which is always square.

$$A = f(a_{ij}) = \begin{bmatrix} 1 & \frac{a_1}{a_2} & \dots & \frac{a_1}{a_n} \\ \frac{a_2}{a_1} & 1 & \dots & \frac{a_2}{a_n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{a_n}{a_1} & \frac{a_n}{a_2} & \cdots & 1 \end{bmatrix} \quad (1)$$

$\frac{a_i}{a_j}$ are the relative weights for *i* for parameter *j* given by the expert following the fundamental scale of Saaty, where n is the number of parameters or sub-dimensions, and $a_{ij}$=1 or $a_{ij} = \frac{1}{a_{ji}}$ and $a_{ij} \neq 0$

AHP facilitates the decision-making assessment in hierarchies that involve dimensions, sub-dimensions and parameters, transforming subjective assessments into an objective one (Ma et al., 2018). $a_{ij}$ is the *i*th row depending on column *j* and $W = (W_1 + W_2 + \cdots + W_n)$, where $W_i$ represents the weight of the *i*th parameter. In this study, Eq. 2 was utilised for the normalisation vector matrix and Eq. 3 was used for the calculation of the weight of the parameter.

$$a_{ij}{}^* = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \quad (2)$$

$$W_i = \frac{\sum_{j=1}^{n} a_{ij*}}{n} \quad (3)$$

For all *i*=1, 2, …, n

Saaty (2008) demonstrated a relationship between the vector-matrix weights *W* and pairwise comparison matrix *A*, as illustrated in Eq. 4.

$$A_W = \lambda_{max} W \quad (4)$$

After obtaining the weights of the parameters, the consistency index (*CI*) value was calculated using Eq. 5.

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (5)$$

According to Wind & Saaty (1980), the Consistency Ratio (*CR*) requires a Random Index (RI) to judge the parameters of expert opinions. The RI values for the number of parameters can be found in Table 1.

Table 1: Random Index (RI)
*Source: Saaty, 2008*

| n | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| RI | 0.00 | 0.00 | 0.58 | 0.90 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 | 1.49 |

$$CR = \frac{CI}{RI} \quad (6)$$

If the consistency ratio (*CR*) is below 0.10 (or 10%), then the result is sufficiently accurate, and there is no requirement for further adjustment in the comparison matrix or for repeated calculations (Saaty, 1987).

## 4. Result and Findings

After obtaining the desired list of parameters, 12 selected experts were asked to verify the relevant parameters that contributed to the assessment process of the Co-Working and Co-Living Hub. The experts were chosen based on their minimum of ten years of experience in fields such as academia, professional architecture, economics and environmental expertise. Their consensus opinion was used to finalise the final list of parameters. According to Brace (2008), *"Itemised rating scales are used to help the researcher obtain a measure of attitudes. The researcher first develops several dimensions – attitude statements, product or service attributes, image dimensions, etc. Respondents are then asked to position how they feel about each one using a defined rating scale."* Following a similar approach, this Delphi process was adopted where experts provided descriptions of the parameters and their relevant scale of measurement.

To select the parameters, a triangulation method was used. Parameters with mean values of more than 4, median values of 4, interquartile range values of 2 and 75% of responses ranging from strongly agree (4) to extremely agree (5) were chosen for the design of co-living and co-working spaces. After two rounds of the Delphi process, the results were obtained and presented in Table 2.

Table 2: Selection of Parameters for the Assessment of Designing Co-Working and Co-Living Spaces
*Source: Authors*

| Parameters | Mean | Median | IQR | Nos 4 + Nos 5 |
|---|---|---|---|---|
| Accessibility | 4.56 | 5.00 | 1.00 | 93.75% |
| Acoustical Problems | 4.13 | 4.00 | 0.25 | 87.50% |
| Aesthetic | 4.25 | 4.00 | 1.00 | 93.75% |
| Amenities | 4.81 | 5.00 | 0.00 | 100.00% |
| Building Height | 4.00 | 4.00 | 2.00 | 62.50% |
| Building Materials | 4.19 | 4.00 | 1.00 | 87.50% |
| Bye-Laws | 4.75 | 5.00 | 0.25 | 100.00% |
| Climatic Factor | 4.56 | 5.00 | 1.00 | 100.00% |
| Connectivity | 4.50 | 5.00 | 1.00 | 93.75% |
| Contextual Site Analysis | 4.44 | 4.50 | 1.00 | 93.75% |
| Cost | 3.69 | 4.00 | 1.00 | 62.50% |
| Cultural Aspects | 3.56 | 3.50 | 1.00 | 50.00% |
| Disaster Prone Zone | 4.00 | 4.00 | 2.00 | 68.75% |
| Drainage | 4.25 | 4.00 | 1.00 | 81.25% |
| Flexibility | 4.50 | 5.00 | 1.00 | 93.75% |
| Facade Treatment | 4.00 | 4.00 | 0.00 | 81.25% |
| Safety and Security | 4.63 | 5.00 | 1.00 | 93.75% |
| Flexible Spaces | 4.38 | 4.00 | 1.00 | 93.75% |
| Form | 4.00 | 4.00 | 1.25 | 75.00% |
| Function | 4.63 | 5.00 | 1.00 | 93.75% |
| Green Measures | 4.31 | 4.00 | 1.00 | 100.00% |
| Hardscape | 4.06 | 4.00 | 1.25 | 75.00% |
| Historical Aspects | 2.94 | 3.00 | 0.25 | 18.75% |
| Human Made Features | 3.94 | 4.00 | 0.00 | 81.25% |
| Humidity | 4.19 | 4.00 | 1.00 | 81.25% |
| Interactive Spaces | 4.44 | 5.00 | 1.00 | 87.50% |
| Land Use | 4.63 | 5.00 | 1.00 | 100.00% |
| Legal Information | 4.50 | 5.00 | 1.00 | 93.75% |

| | | | | |
|---|---|---|---|---|
| Light | 4.63 | 5.00 | 1.00 | 93.75% |
| Locally Available Materials | 4.25 | 4.00 | 1.00 | 81.25% |
| Technology | 4.31 | 4.00 | 1.00 | 87.50% |
| Natural Physical Features | 4.19 | 4.00 | 1.25 | 75.00% |
| Negative And Positive Spaces | 4.19 | 4.50 | 1.00 | 81.25% |
| Neighbourhood Context | 4.63 | 5.00 | 1.00 | 100.00% |
| Sustainability Practices | 4.31 | 4.00 | 1.00 | 87.50% |
| Noise Pollution | 4.31 | 4.50 | 1.00 | 87.50% |
| Orientation | 4.38 | 4.50 | 1.00 | 87.50% |
| Pedestrian Circulation | 4.50 | 4.50 | 1.00 | 100.00% |
| Population Density of Place | 3.81 | 4.00 | 2.00 | 68.75% |
| Passive Design Strategies | 3.94 | 4.00 | 0.50 | 75.00% |
| Preliminary Zoning | 4.31 | 4.00 | 1.00 | 87.50% |
| Privacy | 4.31 | 4.00 | 1.00 | 87.50% |
| Public And Private Spaces | 4.56 | 5.00 | 1.00 | 87.50% |
| Rainwater Harvesting | 4.56 | 5.00 | 1.00 | 87.50% |
| Recreational Area | 4.56 | 5.00 | 1.00 | 93.75% |
| Residential Complex | 4.38 | 5.00 | 1.00 | 81.25% |
| Sensory | 4.19 | 4.00 | 1.00 | 87.50% |
| Site Zoning | 4.44 | 4.00 | 1.00 | 100.00% |
| Slope Of the Site | 4.13 | 4.00 | 1.00 | 87.50% |
| Softscape | 3.88 | 4.00 | 1.25 | 68.75% |
| Soil Type | 4.00 | 4.00 | 1.25 | 75.00% |
| Energy-Efficient Systems | 4.13 | 4.00 | 1.00 | 81.25% |
| Structural Strength | 4.50 | 5.00 | 1.00 | 93.75% |
| Indoor Air Quality | 4.56 | 5.00 | 1.00 | 87.50% |
| Thermal Comfort Systems | 4.75 | 5.00 | 0.00 | 93.75% |
| Topography | 4.44 | 5.00 | 1.00 | 93.75% |
| Utility | 4.25 | 4.50 | 1.00 | 81.25% |
| Vehicular Circulation | 4.56 | 5.00 | 1.00 | 100.00% |
| Ventilation | 4.75 | 5.00 | 0.25 | 100.00% |
| Vertical Interactive Spaces | 4.25 | 5.00 | 1.00 | 81.25% |
| Views | 4.38 | 4.50 | 1.00 | 87.50% |
| Wind Direction | 4.50 | 5.00 | 1.00 | 87.50% |

The result of Table 2 shows that based on expert consensus, parameters such as building height, cost, cultural aspects, disaster-prone area, historical aspects, population density and softscape are not suitable for designing the co-working and co-living hub. Through the Delphi method, these parameters were selected from a list of potential parameters to determine their importance levels.

As outlined in Section 4.2, the AHP was utilised with input from the same experts involved in the Delphi method. This approach helped identify and prioritise important parameters for the project (Table 3).

Local and global weights are two concepts used in AHP to measure the importance of variables in a dataset. Local weights are calculated for each dimension or the broader area, while global weights are calculated for the entire dataset. Local weights are used to measure the importance of a particular area for a specific instance in a dataset. They are calculated by comparing the feature values of the parameters to the dimensional values of other parameters in the dataset. Parameters with high local weights are more important for predicting the target variable for a specific parameter. Global weights are used to measure the importance of a parameter for assessing the total value superseding the mid-level dimensions. They are calculated by averaging the local weights for all parameters in the dataset. Parameters with high global weights are more

Table 3: Determining the Importance of Dimensions and Parameters in the Design of Co-Working and Co-Living Spaces
*Source: Authors*

| Dimensions | Level of Importance of the Dimensions | Parameters | Local Weights of the Parameters | Global Weights of the Parameters |
|---|---|---|---|---|
| **Circulation** | 19.53% | Accessibility | 32.51% | 6.35% |
| | | Connectivity | 21.66% | 4.23% |
| | | Pedestrian Circulation | 21.43% | 4.19% |
| | | Vehicular Circulation | 24.40% | 4.77% |
| **Climate** | 15.86% | Humidity | 12.71% | 2.02% |
| | | Light | 14.64% | 2.32% |
| | | Orientation | 17.46% | 2.77% |
| | | Passive Design Strategies | 11.30% | 1.79% |
| | | Energy-Efficient Systems | 9.78% | 1.55% |
| | | Indoor Air Quality | 9.31% | 1.48% |
| | | Thermal Comfort Systems | 12.61% | 2.00% |
| | | Wind Direction | 12.18% | 1.93% |
| **Services** | 15.67% | Acoustical Problems | 17.46% | 2.74% |
| | | Amenities | 20.54% | 3.22% |
| | | Flexibility | 22.86% | 3.58% |
| | | Safety and Security | 15.63% | 2.45% |
| | | Technology | 12.85% | 2.01% |
| | | Sustainability Practices | 10.66% | 1.67% |
| **Site and Surroundings** | 14.07% | Bye-Laws | 13.06% | 1.84% |
| | | Contextual Site Analysis | 11.87% | 1.67% |
| | | Drainage | 10.08% | 1.42% |
| | | Land Use | 9.17% | 1.29% |
| | | Legal Information | 8.19% | 1.15% |
| | | Neighbourhood Context | 10.04% | 1.41% |
| | | Noise Pollution | 6.94% | 0.98% |
| | | Site Zoning | 8.95% | 1.26% |
| | | Slope of the Site | 8.23% | 1.16% |
| | | Soil Type | 6.66% | 0.94% |
| | | Topography | 6.80% | 0.96% |
| **Sustainability** | 15.30% | Building Materials | 23.86% | 3.65% |
| | | Facade Treatment | 16.28% | 2.49% |
| | | Green Measures | 19.78% | 3.03% |
| | | Locally Available Materials | 17.43% | 2.67% |
| | | Natural Physical Features | 10.12% | 1.55% |
| | | Rainwater Harvesting | 12.52% | 1.91% |
| **Design Elements** | 10.33% | Aesthetic | 10.73% | 1.11% |
| | | Form | 10.22% | 1.06% |
| | | Function | 15.27% | 1.58% |
| | | Hardscape | 7.63% | 0.79% |
| | | Human Made Features | 7.89% | 0.82% |
| | | Residential Complex | 9.33% | 0.96% |
| | | Sensory | 5.71% | 0.59% |
| | | Structural Strength | 11.52% | 1.19% |
| | | Utility | 8.29% | 0.86% |
| | | Ventilation | 7.36% | 0.76% |
| | | Views | 6.05% | 0.62% |
| **Design Spaces** | 9.23% | Flexible Spaces | 15.61% | 1.44% |
| | | Interactive Spaces | 13.50% | 1.25% |
| | | Negative And Positive Spaces | 11.83% | 1.09% |
| | | Preliminary Zoning | 15.31% | 1.41% |
| | | Privacy | 14.22% | 1.31% |
| | | Public And Private Spaces | 13.26% | 1.22% |
| | | Recreational Area | 8.45% | 0.78% |
| | | Vertical Interactive Spaces | 7.82% | 0.72% |

important for predicting the target parameter for the entire dataset. Table 3 shows the level of importance of the parameter under each dimension as well as for the overall assessment process. Local weights of the parameters show their level of contribution for their respective dimensions; whereas, the global weights of the parameters exhibit their contribution to the overall assessment process. Simultaneously, using the AHP process for the dimensions, their levels of importance are obtained. The global weights of the parameters are obtained by multiplying the local weights of the parameters with their respective dimensional weights. For designing the co-living and co-working hub, the Accessibility (6.35%) parameter is found to be the most important parameter whereas the Sensory (0.59%) parameter is found to be the least important parameter.

## 5. Discussion

The Delphi and AHP methods are two qualitative decision-making methods that were used to study the design of a co-living and co-working hub. The Delphi method is a structured communication technique that can be used to gather and synthesise expert opinions. It involves a cyclical process with a panel of 12 experts anonymously providing their opinions on parameters for designing a co-living and co-working hub. The opinions are collected and analysed and experts are asked to provide feedback, repeating the process until a consensus is reached. The AHP method is a multi-criteria decision-making method used to determine the weights of criteria. It is a hierarchical process involving selecting parameters and finding their weights. Both the Delphi and AHP methods were utilised in designing a co-living and co-working hub by first identifying a panel of experts and stakeholders, which could include potential residents, potential workers and community members. Once identified, stakeholders are asked to provide their opinions on the parameters. The Delphi and AHP methods can be used to design a co-living and co-working hub that meets the needs of stakeholders. These methods provide a systematic way to gather and synthesise expert opinions and rank alternatives.

## 6. Conclusion

This study has identified and selected dimensions and parameters for the design of co-working and co-living spaces in a post-pandemic world. The Delphi and AHP methods were used to gather and synthesise expert opinions on topics such as circulation, climate, services, site and surroundings, sustainability, design elements and design spaces. The results of this study highlighted the important dimensions and parameters for the design of co-working and co-living spaces in a post-pandemic world. However, this study has some limitations. First, the Delphi and AHP methods are qualitative and cannot generate quantitative data. Secondly, the panel of experts was small, and the results may not be generalisable to the entire population. Thirdly, the study was conducted in a specific context and the results may not apply to other contexts. Despite these limitations, this study has made a significant contribution to the field of co-working and co-living spaces. The results can be used by developers and designers to create spaces that meet the needs of users in the post-pandemic world. Future work for this study includes conducting a larger study with a more diverse panel of experts; generating quantitative data using quantitative methods; studying in different contexts to determine generality; and developing a theoretical framework for the design of co-working and co-living spaces. In conclusion, this study has laid the foundation for future research on the design of co-working and co-living spaces. The results of this study can be used to create spaces that are safe, sustainable and promote a sense of community.

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**Dr. Partha Sarathi Mishra** is a faculty member at the Faculty of Architecture, Sri Sri University, Cuttack (IIA-affiliated). He has a Ph.D. from the Department of Planning and Architecture, National Institute of Technology, Rourkela, Odisha. He holds an M. Arch. from the Indian Institute of Technology, Roorkee. His research focuses on the evaluation of architectural heritage for designating 'Odishan Temple Architecture' through various multi-criteria decision-making analyses.
*Email: partha.m@srisriuniversity.edu.in*

**Ar. Debasis Das** is an Assistant Professor in the Faculty of Architecture at Sri Sri University, Cuttack. He holds a Master of Architecture degree from the Indian Institute of Technology, Roorkee. His research focuses on urban design, placemaking, public art and visual semantics.
*Email: debasis.d@srisriuniversity.edu.in*

**Dr. Abhiroop Das** is an Associate Professor, Dept. of Architecture, Sister Nivedita University, New Town, Kolkata. He has an M. Arch. and Ph.D. from Jadavpur University. He has 4 years of Industrial Experience and 14 years of Teaching Experience. His area of research is the parametric study of urban transformations related to MRTS and urban developments in the city core areas.
*Email: abhirooparch76@gmail.com*

RESEARCH PAPER

# Spatial Evolution and Gendered Mobility in JuiKhurd

## Analysing Architectural and Socio-Cultural Transformations in a Rural Settlement

By Ar. Namita Singh and Dr. Suruchi Modi

**ABSTRACT**

This study examines the spatial evolution and gendered mobility in JuiKhurd, a rural settlement in Bhiwani, Haryana, analysing how architectural transformations, socio-cultural norms and infrastructural advancements influence movement patterns and space utilisation. The research integrates qualitative and quantitative methodologies, including participatory mapping, structured interviews and spatial analysis, to explore generational differences in mobility and access to public and private spaces. Findings indicate that while modernisation has introduced infrastructural improvements, deep-rooted patriarchal structures continue to shape spatial behaviour, particularly restricting women's autonomy in public domains. The study highlights the contrast between generational movement patterns, with younger women experiencing greater access to education and economic opportunities compared to older generations. However, traditional social expectations still govern female participation in external economic activities. Architectural analysis further demonstrates an incremental evolution in housing typologies, balancing vernacular design elements with modern amenities. The research underscores the complex interplay between modernisation and cultural retention in rural settlements, emphasising the need for gender-inclusive spatial planning. The study concludes that a balanced approach integrating traditional socio-spatial patterns with progressive infrastructure and policy interventions is essential for equitable rural development.

**KEYWORDS:** Rural Spatial Transformation, Gendered Mobility, Vernacular Architecture, Socio-Cultural Dynamics, Inclusive Planning

### 1. INTRODUCTION

Rural settlements in India exhibit a complex relationship between tradition and modernisation, where socio-cultural norms shape spatial organisation, mobility patterns and built environments (Sen, 1999). The village of JuiKhurd, located in Bhiwani, Haryana, serves as a compelling case study of this dynamic interplay. While modernisation has facilitated improvements in education, sanitation and transportation, traditional gender roles continue to influence movement patterns and access to public spaces (Singh, 2019).

This research aims to investigate how the built environment, mobility trends and generational shifts contribute to the evolving spatial landscape of JuiKhurd. Existing literature on rural settlements and gendered mobility highlights that social structures often impose restrictions on women's movement, limiting their participation in economic and public life (Datta, 2016). In many rural areas, women's mobility is confined to domestic and semi-public spaces, while men dominate marketplaces, communal areas and economic hubs (Chant, 2013).

Despite improvements in education and infrastructure, societal expectations still govern female autonomy, restricting their ability to navigate urban centres and employment opportunities (Moser, 1993). The case of JuiKhurd illustrates these contradictions, where physical infrastructure has

modernised, but social attitudes have evolved more slowly.

This study seeks to answer the following key research questions:

- How have infrastructural developments influenced the socio-spatial structure of JuiKhurd?
- How do gender norms affect spatial mobility and accessibility within the village?

By employing a case study approach, this research integrates spatial mapping, structured interviews and participatory observations to examine how rural architectural transformations impact gendered mobility and social inclusion. The findings contribute to the broader discourse on rural planning, gender-equitable spaces and vernacular architecture, offering insights for policymakers and planners aiming to develop inclusive rural settlements that balance cultural traditions with progressive development.

## 2. METHODOLOGY AND CASE STUDY ANALYSIS

This study employs a qualitative case study approach, integrating ethnographic methods, participatory mapping and spatial analysis to examine gendered mobility and architectural transformations in JuiKhurd. A mixed-method framework was adopted to investigate how infrastructure, cultural norms and economic changes shape movement patterns and spatial utilisation in the village. The methodology is informed by prior research on rural settlements and gendered spatial experiences (Bourdieu, 1977; Lefebvre, 1991), ensuring a multidisciplinary approach that bridges architectural analysis, mobility studies and socio-cultural dynamics.

### 2.1 Data Collection and Sampling

A purposive sampling strategy was employed to ensure a representative cross-section of the village population, with a focus on three generational cohorts of women: The grandmother generation (60+ years) – primarily engaged in household and religious spaces with limited mobility. The mother generation (35–59 years) – exhibiting semi-public movement, including access to markets, schools and social gatherings, though still restricted in independent decision-making. The daughter generation (18–34 years) – experiencing increased access to educational institutions and employment centres, yet still bound by societal expectations regarding safety and propriety (Singh, 2019). Primary data collection methods included: Semi-structured interviews with 55 women across these age groups, focusing on daily routines, mobility restrictions and perceptions of spatial autonomy. Focus Group Discussions (FGDs) involving 289 participants (both men and women), exploring themes of economic participation, spatial movement and the impact of infrastructure on daily life. Spatial mapping using GPS tracking and participatory observation, recording movement patterns of different generational groups and enabling a comparative analysis of mobility trends over time. Architectural surveys documenting housing typologies, public space usage and infrastructural modifications, assessing how the built environment has evolved in response to socio-economic changes (Lefebvre, 1991).

### 2.2 Case Study of JuiKhurd

JuiKhurd, a rural settlement spanning 1,775 hectares, has a population of 6,821 residents with a literacy rate of 63.47% (Census of India, 2011). The village is strategically positioned along a national highway, facilitating commercial expansion and infrastructural modernisation. Despite these developments, cultural structures continue to dictate gendered access to spaces, limiting women's mobility and participation in external economic activities (Datta, 2016). Unlike many rural settlements featuring centralised public squares (chaupals) as community hubs, JuiKhurd exhibits a decentralised social structure, where gathering spaces are dispersed and often gender-segregated. The historical reliance on camel-driven transportation for water access illustrates how infrastructural limitations shaped past mobility restrictions. With the introduction of piped water, electricity and paved roads, household labour burdens have decreased, but social expectations around movement and space utilisation remain largely unchanged (Moser, 1993).

### 2.3 Architectural Evolution and Spatial Organisation

The architectural evolution of JuiKhurd reflects incremental functional modifications yet maintains traditional gendered spatial hierarchies. The study documents how housing layouts, gathering spaces and public infrastructure have shifted over time (Table 1).

The data indicate that while functional improvements in housing design have enhanced privacy, sanitation and security, they have not disrupted the traditional social organisation of gendered spaces. The spatial organisation of JuiKhurd continues to reflect distinct gendered patterns, where markets, roadside tea stalls and communal pavilions remain exclusively male-dominated, reinforcing gendered divisions in public life (Chant, 2013), while female-centric domestic spaces such as courtyards, kitchen areas

**Table 1:** Evolution of Housing Typologies in JuiKhurd
*Source: India Infrastructure Report, 2020; Architectural Digest India, 2022*

| Decade | Key Features | Water & Sanitation |
|---|---|---|
| 1960s | Large open courtyards, livestock areas | Communal wells, open bathing areas |
| 1980s | Introduction of enclosed bathing spaces | Piped water introduced |
| 1990s | Attached toilets, defined kitchen areas | Household-level toilets introduced |
| 2000s | Boundary walls, secure windows & doors | Widespread tap water access |
| Present | Integration of modern amenities with vernacular elements | Enclosed sanitary units, wastewater systems |

and small-group gathering spots continue to serve as primary interaction zones for women, limiting their engagement with larger civic and economic networks (Datta, 2016).

The built environment's persistence in gender-segregated layouts highlights the slow pace of cultural transformation, demonstrating that despite infrastructural advancements, societal expectations still dictate women's mobility and participation in external work and social activities (Sen, 1999). While younger women now have greater access to education and transport, their ability to fully engage in professional and economic domains remains shaped by traditional norms, reinforcing the ongoing need for gender-sensitive planning and policy interventions.

## 3. RESULTS AND FINDINGS

The findings from the case study of JuiKhurd reveal significant insights into spatial mobility patterns, gendered access to public spaces and the evolution of domestic architecture. The study highlights the contrast between modern infrastructural advancements and entrenched socio-cultural norms, particularly regarding women's mobility, economic participation and architectural transformations.

### 3.1 Gendered Mobility and Spatial Access

A key finding of the study is the variation in spatial mobility across different generations of women. While older women (60+ years) remain largely confined to domestic and religious spaces, younger generations (18–34 years) exhibit increased access to education and employment (Table 2). However, cultural constraints continue to regulate women's movement in public and economic spaces (Singh, 2019).

The grandmother generation has the lowest mobility, with movement restricted to household courtyards, religious sites and immediate neighbourhood clusters (Figure 1). These women grew up when water transport and agricultural labour were male-dominated, reinforcing domestic spatial confinement (Census of India, 2011).

The mother generation experiences moderate movement, including occasional market visits and school interactions, though societal norms still

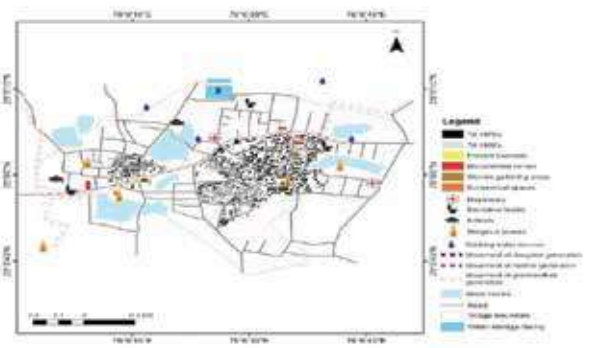

Figure 1: Physical Movement Map of Grandmother
*Source: Authors*

**Table 2: Generational Mobility Patterns in JuiKhurd**
*Source: UN-Habitat, 2016; Singh, 2019*

| Generation | Primary Mobility Areas | Frequency of Movement | Restrictions |
|---|---|---|---|
| Grandmother (60+ years) | Domestic & Religious Spaces | Low | Strong |
| Mother (35-59 years) | Semi-Public Areas (Markets, Schools for Children) | Moderate | Moderate |
| Daughter (18-34 years) | Educational & Employment Centers | High | Limited |

dictate their presence in external spaces (Figure 2). Women in this age group often rely on male family members for transportation and rarely participate in decision-making regarding land ownership or business transactions (Datta, 2016).

The daughter generation exhibits the highest degree of spatial freedom, with increased access to schools, universities and workspaces (Figure 3). However, the study found that even among young women, mobility remains conditional, often requiring parental approval, accompaniment by male relatives or adherence to specific dress codes and behavioural expectations (Moser, 1993).

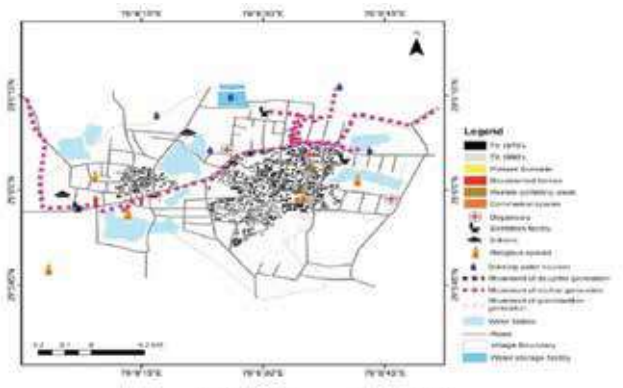

Figure 2: Physical Movement Map of Mother
*Source: Authors*

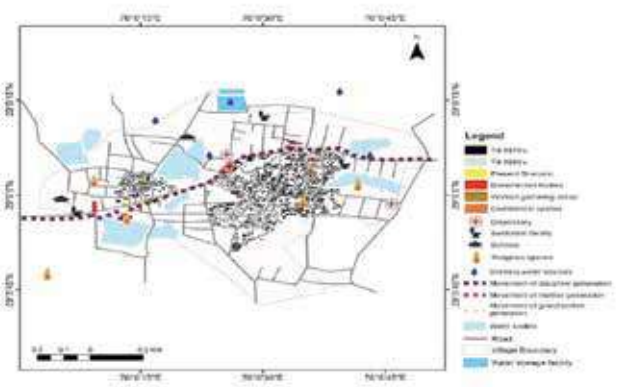

Figure 3: Physical Movement Map of Daughter
*Source: Authors*

### 3.2 Evolution of Architectural Typologies in JuiKhurd

The architectural transformation of JuiKhurd's housing typologies provides a clear reflection of socio-economic changes while retaining traditional spatial organisation. The study documents how housing layouts, gathering spaces and public infrastructure have evolved to incorporate modern amenities while preserving gender-segregated spaces (Figure 4).

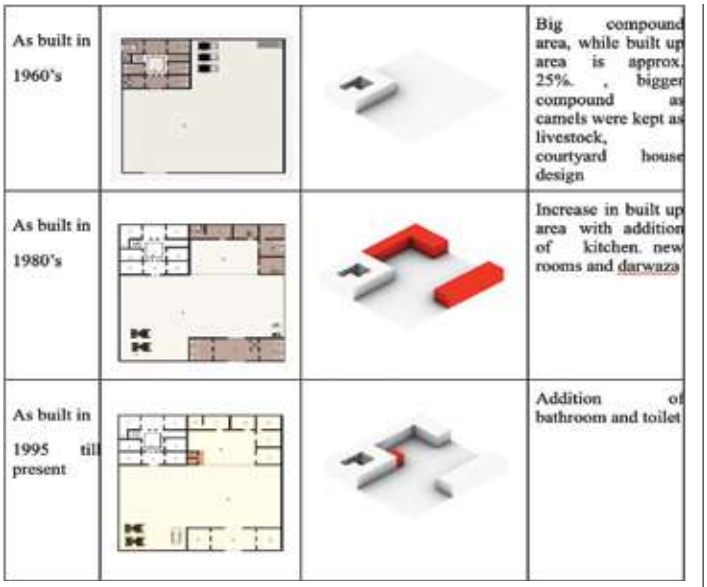


Figure 4: Evolution of Space within home
*Source: Authors*

The data highlight that while functional improvements in housing design have enhanced privacy, sanitation and security, they have not disrupted traditional social structures. Despite modernised homes with attached kitchens, toilets and defined personal spaces, gendered spatial segregation remains intact, with male-dominated gathering areas (such as outdoor seating and public courtyards) separate from female-dominated interiors (Chant, 2013).

### 3.3 Socio-Economic Changes and Public Space Utilisation

Although economic diversification has expanded in JuiKhurd, employment opportunities for women remain largely restricted to informal and home-based labour. The study found that while young women increasingly pursue education, their transition into the workforce is significantly lower due to social norms regarding appropriate occupations for women (World Bank, 2021). Public spaces in JuiKhurd remain highly gendered, with men dominating commercial and civic areas while women's engagement is largely confined to domestic and semi-public settings.

### 3.4 Impact of Infrastructural Development on Daily Life

The introduction of paved roads, electricity and improved sanitation has reduced physical labour burdens for women, but it has not translated into enhanced mobility or economic independence. For instance, while households now have piped water, reducing the need for daily water-fetching trips, the freed-up time is often redirected towards unpaid domestic labour rather than external work opportunities (UNDP, 2019). The availability of

higher education institutions in nearby towns has increased female literacy rates, but employment remains low due to social restrictions on workplace participation. Many women, even after receiving higher education, are encouraged to prioritise marriage and domestic responsibilities over professional careers (Sen, 1999).

## 4. DISCUSSION

The findings from the case study of JuiKhurd reveal a complex interplay between modernisation, traditional gender norms and spatial organisation. While infrastructural advancements have enhanced accessibility to education, sanitation and transportation, deeply ingrained patriarchal structures continue to influence movement patterns, economic participation and public space utilisation.

### 4.1 The Paradox of Mobility and Gendered Spaces

One of the key observations in this study is that physical infrastructure alone does not automatically translate into gender-inclusive spatial access. Despite increased educational opportunities and improved roads, women's mobility remains heavily restricted by social norms. This aligns with previous research that highlights how gendered mobility constraints are often dictated by societal perceptions of propriety and safety rather than the mere availability of transport infrastructure (Singh, 2019). In JuiKhurd, younger women have greater access to education and transport but still require male escorts for long-distance travel. This supports findings from other rural studies, where female autonomy in movement is conditional on social approval rather than personal agency (Chant, 2013). Additionally, public spaces such as markets and communal seating areas remain dominated by men, reinforcing gendered divisions of space despite infrastructural improvements (Datta, 2016).

This paradox highlights that while modernisation provides opportunities for spatial freedom, societal norms continue to dictate behavioural expectations, limiting the practical benefits of infrastructural progress.

### 4.2 Architectural Evolution and Retention of Gendered Spatial Divisions

The study found that housing structures in JuiKhurd have undergone significant functional improvements, yet they still reflect deep-seated gendered spatial divisions. The integration of attached toilets, enclosed kitchens and modern amenities has improved sanitation and domestic convenience, but private spaces remain distinctly separated along gender lines. This mirrors broader patterns observed in vernacular settlements, where modernisation is layered onto traditional layouts rather than fundamentally altering them (Architectural Digest India, 2022). Despite the introduction of modern household designs, the spatial logic of gender segregation persists. Public and semi-public spaces such as courtyards and neighbourhood gathering areas continue to be gender-specific, limiting cross-gender social interactions and economic collaboration. This indicates that architectural evolution is driven by practical necessity rather than social transformation, reinforcing previous findings that infrastructure development does not inherently dismantle patriarchal spatial hierarchies (Moser, 1993). The challenge, therefore, lies in designing adaptive rural housing solutions that integrate both cultural continuity and gender inclusivity. Future rural planning efforts must go beyond functional improvements and actively incorporate gender-sensitive spatial planning.

### 4.3 Socio-Economic Participation and Structural Gender Barriers

Although literacy rates among younger women in JuiKhurd have improved, their transition into the workforce remains significantly limited. The study found that social norms continue to prioritise domestic roles over professional engagement, reflecting findings from previous research that suggest economic autonomy for rural women is often shaped by familial expectations rather than personal aspirations (World Bank, 2021). The economic landscape of JuiKhurd remains male-dominated, with women primarily engaged in domestic labour or small-scale home-based enterprises. Public spaces for trade, networking and business decision-making are largely inaccessible to women, reinforcing their economic marginalisation. While microfinance initiatives and self-help groups have been introduced in similar rural settlements to promote women's entrepreneurship, JuiKhurd has yet to adopt these models widely, demonstrating a gap between policy interventions and localised cultural acceptance (UNDP, 2019). This suggests that economic empowerment programmes must be tailored to rural socio-cultural contexts, ensuring that interventions are socially accepted and practically feasible. Without addressing deep-rooted gender biases, economic opportunities for women will continue to be underutilised regardless of available infrastructural support.

### 4.4 Public Space Exclusion and the Need for Inclusive Design

One of the most striking findings of the study is the gendered exclusion from public spaces in JuiKhurd, where market areas, roadside tea stalls and communal seating spaces remain overwhelmingly male-dominated, reinforcing social barriers that limit women's participation in external economic activities. While religious spaces are accessible to women, they maintain spatial segregation with designated seating and behavioural expectations that conform to gender norms. As a result, women's social interactions are largely confined to private or semi-public spaces, restricting their engagement with larger civic and economic networks (Chant, 2013). This highlights the urgent need for gender-sensitive public planning interventions, as research suggests that introducing gender-inclusive urban designs in rural settlements, such as dedicated women's marketplaces and community centres, can improve economic engagement and spatial autonomy (UN-Habitat, 2016). To achieve gender-equitable spatial planning, JuiKhurd must incorporate women-friendly commercial zones where female entrepreneurs can engage in trade and business without social barriers, along with integrated community spaces that encourage cross-gender interactions in a culturally acceptable manner. Additionally, safer public transport infrastructure must be developed to facilitate independent mobility for women beyond immediate domestic spaces. Without these targeted planning efforts, gender-based spatial exclusion will persist, reinforcing economic disparities and social isolation for women.



### 4.5 Bridging the Gap between Tradition and Modernisation

The case study of JuiKhurd underscores a critical challenge in rural development, where modernisation without social transformation leads to uneven progress. While infrastructural advancements have improved sanitation, literacy and connectivity, deep-seated gender norms continue to restrict women's spatial and economic agency, limiting their ability to benefit fully from development efforts. Research suggests that for rural settlements to achieve holistic growth, development models must balance cultural continuity with progressive planning strategies (Sen, 1999). This requires recognising the value of traditional social structures while integrating modern interventions that promote inclusivity, developing policy frameworks that align with local cultural sensitivities to ensure socially sustainable gender-equitable reforms and encouraging participatory planning where rural women actively shape community spaces, employment opportunities and mobility policies. These steps are essential in bridging the existing gap between tradition and modernisation, ensuring that infrastructure development translates into tangible improvements in social equity, allowing for sustainable and inclusive progress in rural communities.

## 5. CONCLUSIONS

The study of JuiKhurd illustrates the contradiction between infrastructural modernisation and entrenched socio-cultural norms in rural India. While improvements in education, sanitation and transportation have enhanced quality of life, they have not fundamentally altered gendered mobility patterns or economic participation. Women, particularly in older generations, continue to face restrictions in accessing public and economic spaces despite greater educational and infrastructural opportunities for younger cohorts. The architectural evolution of the village has integrated modern amenities yet retained traditional gendered spatial divisions, highlighting the slow pace of cultural transformation. Public spaces in JuiKhurd remain overwhelmingly male-dominated, restricting women's ability to engage in commercial, civic and professional activities. These findings reinforce the notion that infrastructure alone cannot dismantle structural gender barriers—social change must accompany physical development. To foster inclusive and sustainable rural development, targeted gender-sensitive policies and planning interventions must be implemented. This includes creating women-friendly public spaces, enhancing economic participation through skill development and entrepreneurship programmes and ensuring safer mobility infrastructure to facilitate independent movement. Encouraging community-based participatory planning, where women actively shape local development initiatives, can bridge the gap between tradition and modernisation. Integrated policy frameworks should promote equitable access to education, employment and public spaces, ensuring that modernisation benefits all members of society irrespective of gender. By balancing cultural continuity with progressive planning, JuiKhurd and similar rural settlements can transition towards a more inclusive, economically vibrant and socially equitable future.

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**Ar. Namita Singh** (A25543) is a Research Scholar at the School of Architecture and Art (SAA), Sushant University. Her research explores the evolution of social spaces for women in rural Hisar, Haryana. She holds a Master's in Sustainable Architecture from CEPT University and a B. Arch from Chandigarh College of Architecture. Her interests include gender studies, vernacular architecture and environmental studies.
*Email: bamel.namita@gmail.com*

**Dr. Suruchi Modi** (A21778) is a Senior Professor and Head of the Department at the School of Art and Architecture, Sushant University. An architect and urban designer from CEPT University, she specialises in Tall Building Design (University of Nottingham, UK) and holds a doctorate from SPA, New Delhi. Her research focuses on social spaces for children in high-rises. An award-winning architect, she has received international recognition for sustainable skyscraper design.
*Email: suruchimodi@sushantuniversity.edu.in*

**RESEARCH PAPER**

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# Learning Environs in Architecture Studios

## A Living Labs Approach

**By Ar. Shital Golhar**

**ABSTRACT**

Living laboratories are dynamic innovation environments integrated into authentic settings. They use ongoing feedback loops to foster innovative solutions that endure. These collaborative environments—based on the principles of pervasive intelligence and user involvement—are typically initiated by a range of stakeholders, including companies, academic institutions and governments, to promote the creation, testing, verification and evaluation of novel services, goods and systems in real-world contexts. Notably, living labs have supported sustainability objectives and provided venues for student participation and environmental awareness. Emphasising collaborative learning, hands-on experience and group creativity, schools of architecture integrate living laboratories into their curricula to offer students meaningful real-world exposure and strengthen links between academic pursuits, community engagement and industry partnerships. This study highlights the vital role of living laboratories in facilitating immersive learning experiences and fostering continuous educational opportunities by examining the infrastructure supporting the construction and operation of living labs in architectural studios. The research will contribute to identifying the spatial requirements and physical environment needed for architecture schools.

**KEYWORDS**: Living Labs, Architecture School, Infrastructure, Architectural Studios, Learning Environment

### 1. INTRODUCTION

Living laboratories (LL) are user-centric open innovation systems that involve all stakeholders in the process of cocreation, prototyping, validating and testing in a real-life context. It is an iterative process based on feedback, research collaboration and innovation. The goals of LL are to provide an environment for prototyping and evaluating interventions. The praxis followed by LL has mainly centred on institutional campus design and companies delving into cocreation. LL has performed incredibly well in institutional campuses, where students experience great learning environments. Students participate in real-life projects, working with the local community and industry partners. The education system emphasises experiential learning and interdisciplinary collaboration, giving students a lifelong learning experience. The primary objective of LL is to generate sustainable goals for the community. LL involves a public-private-people partnership where interaction and feedback are gathered from all stakeholders at every stage. The labs are connected to citizens for experimentation and testing.

Figure 1 explains the Living Lab infrastructure as the nucleus of a design approach that actively involves users and multiple stakeholders in a natural setting, applying multiple methods to attain long-term goals. Users and stakeholders are involved from the inception of the project. The architectural profession needs to equip itself for new challenges in providing Living Lab infrastructure. Sowing the seeds of research, innovation and practical knowledge

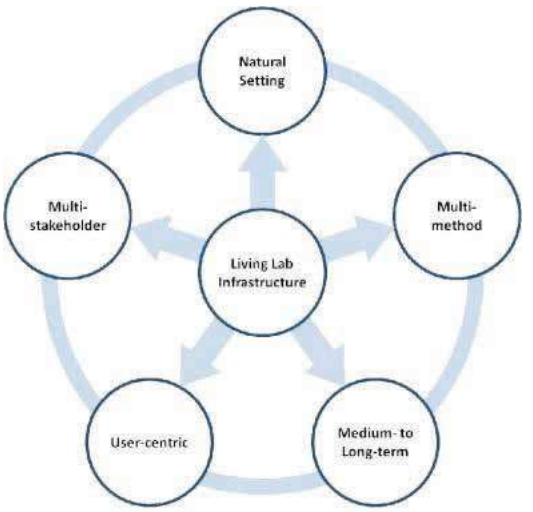


Figure 1: Defining of the elements of Living labs
*Source: Schuurman, D., De Marez, L., & Ballon, P. (2013). Open innovation processes in living lab innovation systems: Insights from the LeYLab. Technology Innovation Management Review, 3(11).*

gives significance to LL, leading to holistic education for budding architects. Schooling in architecture is witnessing a major paradigm shift with the growing demand for new learning methodologies, tools and concepts. The need for proper infrastructure, a suitable physical environment and exposure to experimentation and testing is crucial in architectural education. The academic curriculum deliberates on practical learning, which is limited to internships and site visits in traditional teaching methods, whereas the integration of LL in architectural schools promotes real-life learning from the outset. The objectives for India's future education system are outlined in the National Education Policy of India 2020 (NEP 2020), which was launched by the Union Cabinet of India on 29 July 2020. The policy provides a thorough framework for both vocational training and higher education in rural and urban areas of India (National Education Policy 2020, Ministry of Human Resource Development).

The policy aims to completely transform India's educational system by 2030. Individuals can advance both personally and professionally by taking advantage of the vast array of personal, civic, economic and lifelong learning opportunities outlined in the NEP (New Education Policy 2020, Ministry of Human Resource Development). It aims to achieve the objectives of quality and inclusion by reorienting the educational system to better meet the demands of the twenty-first century. Reforms at every stage of education, from primary school to postsecondary education, are outlined in the policy. It seeks to put greater emphasis on improving teacher preparation, changing the current examination system, enhancing early childhood care and reorganising the educational regulatory structure. The necessity for a holistic view of today's complex socio-economic and environmental conflicts and their possible solutions presents a great opportunity to reinvent and reinforce the role of architects as key figures in these complex social, political and economic processes (Masseck, 2017).

The inclusion of LL in the educational campus will enrich students with a practice-based learning experience, imbibing the concept of sustainable practices at an early stage. It also instils the importance of partnership and team building. Experiential learning helps in knowledge retention and boosts satisfaction, initiates critical thinking and problem-solving ability, while simultaneously equipping students with practical skills that are valued in employment. The NEP (2020) and Living Lab objectives are synonymous and recommend a physical environment that offers high-quality education, rich experiences and employability to students. For architects, designing schools may be an intricate task. In addition to considering sports and leisure activities, they require a variety of spaces for instruction. However, creating an environment that fosters a positive educational atmosphere for students is the greatest challenge, regardless of its size or surface.

**Background**

The concept of "living labs" originated in the early 1990s and was used to refer to spaces at the Massachusetts Institute of Technology (MIT) in Boston, where students conducted real-world projects. It has been discovered that MIT professor William Mitchell was the source of the idea and, through his work, the present House Place Lab at MIT was developed. A room or structure outfitted with specialised equipment for conducting scientific experiments and tests is referred to as a "lab." In a living laboratory, research can be conducted in a real-world setting rather than in a conventional controlled environment. Today, the term "Living Lab" also refers to a European initiative that was launched in 2006 with the goal of building a global network connecting various living lab projects. Several living laboratories with diverse structures and purposes have emerged in recent years. Now, the European Network has approximately 300 registered living labs. Living labs are a concept applied across various fields and industries; thus, defining them in a general way is challenging. Regardless of the discipline or sector for which a living lab was designed, the following provides a comprehensive overview. A living lab

seeks to engage people as proactive collaborators in the development of novel concepts and ideas. An LL is an immersive setting, either real-world or virtual, where people can develop and experience their own futures in an inspired communal environment. This description places creativity, experimentation and collaborative production at the heart of a living laboratory. The necessity of the living lab is fundamentally understood by examining the principles of open innovation, a method for innovation development within the building industry. The ideation of LL is an efficient alternative to traditional investigative and creative processes. LL contributes to better understanding, collaboration and experience for lifelong learning, fostering a sensitive approach to the environment, which shall be a necessity for every project in the future.

**Aim and Objectives**

This study highlights the vital role that living laboratories play in facilitating immersive learning experiences and fostering continuous educational opportunities by providing a thorough examination of the infrastructure supporting the construction and operation of living labs in architectural studios. The research will contribute to providing the spatial requirements and physical environment needed for architecture schools.



## 2. LITERATURE REVIEW

**2.1 Review 1: Architectural Education: Design Studio as Living Labs** (Illes & Kristianova, 2022)

pose two key principles: the learner as an active subject and the role of teachers in ensuring that findings are well supported by being well informed. This threshold of information serves as a foundation for schools to present arguments, carefully interpret evidence and identify valuable questions that need to be asked. The literature demonstrates the workings of an architectural studio for an urban design project using an LL approach. It presents an urban project undertaken by students in cocreation and collaboration with municipalities and public authorities. It also describes a forum in which external agencies participated in the design process. Inputs from participants were further refined to generate design requisites. At every stage, discussions with external agencies were conducted, resulting in experiments that were evaluated and feedback provided following an iterative process. The literature highlights the effective functioning of a studio using the LL approach. However, concerns about infrastructure and the physical environment were only expressed as a virtual platform for communication, discussions and exchange of ideas, whereas studios require a deeper study since students spend most of their time there.

**2.2 Review 2: UNIVERSITY CAMPUS LIVING LABS (UCLL): Unpacking Multiple Dimensions of an Emerging Phenomenon** (Nyborg et al., 2023)

The existing literature on UCLLs primarily focuses on their role as a sustainability instrument and emphasises the exploration of their broader aims and purposes. The article discusses the scope for universities to conduct applied research and teaching in real-world settings through UCLLs. UCLLs offer opportunities for co-creation, testing and validation alongside activities such as industry collaboration and student involvement. The context and inclusive method of co-creation in UCLLs are important aspects that require further study. UCLLs have demonstrated the potential to bring about changes in universities and society, but this remains an empirical question that needs further investigation. The diversity and variability of UCLLs are evident in the examples, with the paper highlighting the need to understand their purpose and form.

**2.3 Review 3: Teaching Sustainability: Living Labs in Architecture. A Framework Proposal for Living Lab Eco-Systems for Teaching, Research and Innovation in The Field of Sustainable Architecture and ESD in Higher Education** (Masseck, 2016)

The notion of Living Labs in architecture and the theories around Education for Sustainable Development (ESD) are reviewed in this paper. It provides case studies to help comprehend the evolution of prototype architecture in relation to sustainability research and education and the rise of Architecture Living Labs. The study creates a tool to classify related projects and identifies commonalities between Architecture Living Labs and ESD frameworks. It details and assesses the case study of ETSAV's (UPC) Living Lab LOW3 action research project.

The LL in architecture has shown potential as an effective teaching and learning resource for sustainable development, sustainable architecture and a sustainable lifestyle, as highlighted in the article. It also emphasises their function as hubs for collaborative innovation and applied research between businesses, academic institutions and the public. The research yielded several conclusions, including the variety of projects housed within Living Labs, the potential for ESD in architecture and the

advantages and disadvantages of Living Labs for sustainability, organisational effectiveness and integration into academic environments.

**2.4 Review 4: Teaching Sustainability Through Living Labs In Architecture: The Case Study of The UPC-LOW3 Prototype** (Masseck, 2013)

The implementation of LOW3, a living lab at the ETSAV School of Architecture, is discussed in this study. LOW3 is a tool for teaching sustainability through collaborative learning and user-centred research. The paper focuses on universities' contributions to sustainable development. The integration of Living Labs in architecture is suggested as an instructional and learning resource. They can be an effective teaching and learning resource for sustainable development in postsecondary education and can help transform societal perceptions of sustainability. The study suggests using the concept as a teaching and learning tool, with particular emphasis on the role of universities in sustainable development. The authors describe Living Lab LOW3 as a Net Zero Energy Building at UPC Barcelona Tech's ETSAV School of Architecture. A commendable effort has been made by the author in discussing the infrastructure required for living laboratories in architecture schools.

**2.5 Review 5: Architecture learning environments: Pedagogy and space in the Universitat Politècnica de Catalunya's Sant CugatCampus** (Moreno & Franquesa, 2023)

The paper examines learning environments in higher education in architecture schools. It compares the Barcelona School of Architecture and the Vallès School of Architecture to understand the practices followed in providing spaces for architecture beyond their formal and functional use. It challenges the statement that architecture learning happens anywhere, anytime, using a model study of the BK City–TU Delft Faculty of Architecture building. The paper covers all the design requirements for the entire school of architecture but does not implement the idea of living labs appropriate to the studio.

**2.6 Review 6: Architecture Design Studio Culture and Learning Spaces: A Holistic Approach to the Design and Planning of Learning Facilities** (Abdullah et al., 2011)

The impact of learning spaces as enduring memories and the studio culture experienced by architecture students are the main topics of the literature. Renowned architects provide students with an understanding of the conception and production stages of design. Using the library reading area as an example, the study discusses outdoor spaces as a crucial aspect of the architectural studio. Additionally, it emphasises the value of communication between the instructor, students and multidisciplinary fields.

## 3. METHODOLOGY

The research designs a set of reference tools used to outline the praxis and methodologies adopted in LL. The tools aim to understand the incorporation of LL in architectural campuses. Secondary data was collected through case studies to examine the effective functioning of an architectural studio as a living lab. The study was conducted to analyse education policy, develop a framework for the future of innovative practices and suggest essential spatial requirements for a learning environment.

An experiment was conducted in architecture school studios with various furniture configurations, after which feedback was collected from students of one batch through a questionnaire. This qualitative data helped understand students' needs and involved them in the process. The data collected was open-ended. Secondary data is collected to formulate the design requirements of an LL for architectural studios.

## 4. DATA ANALYSIS

### 4.1 Studio Learning

The idea of Living Labs focuses on practical experience through the groundbreaking "Action Learning Labs." The Living Lab concept has been utilised in a variety of contexts outside of a school. By employing this method, students were able to apply classroom concepts in practical settings that were closer to their actual experiences.

The University of Tokyo, for example, has its students involved in the local community; Oberlin Community students are change agents in the Oberlin Project, and students in the business management programme at MIT Sloan Living Lab collaborate with corporate and non-profit partners to apply classroom knowledge to high-impact business challenges. Universities throughout Europe have embraced university living labs as instrumental in fostering innovation and enhancing collaboration with a range of stakeholders, including the university, businesses and small to medium-sized enterprises (SMEs). The living labs network around Europe was created in 2006 and has approximately 190 active members worldwide. There are almost 400 member organisations, including IHE, industries and SMEs from countries such as Canada, South Africa, China, Brazil and other European countries such as Ireland, Belgium, Finland and Sweden.

Given the traditional setup of universities, which is more faculty-based with a single-discipline approach that leads to siloed research, teaching and learning, the establishment of university living labs creates an opportunity to overcome that challenge. The experience of a living lab can be summarised by the following key elements: responsible participants, an appropriate college programme, establishing trust through engagement, inclusion in the curriculum and extension beyond the learning stage, while at the same time developing industry engagement and community involvement.

As sustainability challenges are multidisciplinary, there is a common denominator for success in every university-based living lab project. This includes project execution, embracing societal changes, continuing the iterative facilitation process and enlisting strong teamwork from diverse disciplines.

This paper focuses on universities as living labs, where greater attention is given to overcoming internal campus society sustainability challenges, implementing various changes and recognising the urgency to create external linkages beyond their boundaries. For architects, schools are often complex structures to design. Sports and leisure activities must be taken into consideration along with a range of educational spaces. However, beyond its size or surface, the greatest challenge is designing an area that fosters a positive pedagogical environment for children.



### 4.2 Architectural Education

A minimum standard space required for infrastructure approval is proposed by the regulating authorities. Over time, architectural studios have been oriented according to regular sizes. There is a definite hierarchy between the teacher and pupils in a classroom setting that is divisive. Such an atmosphere makes it difficult for pupils to communicate with each other and with their teachers. In a classroom, relationships are frequently restricted to one direction. The Council of Architecture states that any architecture school must have the following space requirements: classrooms with traditional lecture hall arrangements and studios for hands-on instruction with drafting units. The library, art court, multipurpose hall, resource centre, exam room for students and labs for Climatology/Environment, Surveying, Materials Testing, Electrical, Plumbing and Sanitation, Lighting/Illumination and Acoustics, as well as workshops where hands-on learning occurs.

Apart from official schoolwork, the council also suggests providing space for an outdoor sports facility, a canteen, a tuck shop or stationery shop, a reprography section, an open-air theatre with a stage and a permanent exhibition area. In architectural schools, various activities are segregated at site level. Nonetheless, the issue lies in the misconception that instruction occurs solely in physical spaces, disregarding alternative avenues for acquiring knowledge about design. The built component and the landscape can be effective learning tools. Before the pandemic (Covid-19), architectural pedagogy was primarily offline. However, following the pandemic, this changed to an online format, and today, the hybrid teaching-learning mode is widely accepted all over the world. The campus needs to be reassessed as a place where learning takes place and, with changing pedagogy, requires transformation.

### 4.3 Studio Spaces and Design Labs

The studio sizes recommended by the COA are minimum standards followed by schools of architecture in India, allowing a one-way teaching process. Studios aligned with conventional infrastructure requirements were designed for drafting units, confining students to the studios. However, architectural education is fundamentally different from other technical fields, where theoretical learning is more prevalent in comparison. The new educational approach emphasises learning rather than teaching, focusing on students. The majority of learning takes place in the studio. The design of studios is instrumental in students' learning journeys. The school's mission should be to create an atmosphere where students, under the guidance of teachers, learn to assume personal accountability for their education within a comprehensive framework. The establishment of the requisite atmosphere for students' educational growth falls under the purview of the faculty.

### 4.4 Studio hours

The design pedagogy supported by the educational curriculum demands a greater number of hours in the studio. Studios are places for linking theoretical knowledge to practical projects. The Table 1 below states that the number of lecture-based learning hours is far less than studio learning, with studio learning forming the major component of the curriculum. Students spend the maximum number of hours in their studio.

### 4.5 Studio Space requirement

The Council of Architecture is a statutory body of the Government of India under the Architects Act, 1972. Its primary function is to regulate the education and practice of architecture in India and ensure

the maintenance of professional standards for the profession. To bring transparency in the evaluation of schools at the time of inspections and to provide clarity, certain minimum standards regarding studio sizes, laboratories, facilities and furniture are laid out in Architectural Education 2008 (Council of Architecture, statutory body of the Government of India under the Architects Act, 1972, p.1).

In Table 2, the carpet area of a studio for an intake of 40 students is 120 sq. m each, which is 3 sq. m per student (Council of Architecture, statutory body of the Government of India under the Architects Act, 1972, p.6). Traditionally, in a one-way teacher-student relationship, the basic configuration of a studio is rectangular in shape, with the teacher positioned at the front of the studio and students at the back. Table 3 list the provision of furniture and equipment for studios as per COA requirements (Council of Architecture, statutory body of the Government of India under the Architects Act, 1972, p.7).

## 5. RESULTS AND DISCUSSIONS

### 5.1 Experimentation

An experiment was carried out for students of architecture, where, along with the traditional arrangement of furniture with the teacher at the front and students at the back, two more layouts were tested. The layouts were arranged in the studio for a semester, and students' feedback and experience were recorded. A questionnaire was distributed to collect students' experiences and satisfaction levels. The experiment was conducted with two batches of 27 students.

The findings from the data collection indicate that students prefer a flexible furniture layout in the studio. The students preferred: Formal Arrangement – 18%, Informal Arrangement – 64%, Peripheral Arrangement – 27% (Figure 5). They favour an informal arrangement, where interaction with the teacher is best experienced (Figure 6). The current studio sizes (sq. m) are satisfactory for drafting

Figure 2: Formal layout of furniture arrangement of the Studio in polarized environ where the teacher table at the front and students at the back
*Source: Author*

Figure 3: Informal layout with the teachers table in the center and students drafting table arranged around
*Source: Author*

Figure 4: Peripheral Layout arrangement of furniture with the drafting tables and teachers table aligned around the periphery of the studio with open space in the center.
*Source: Author*

Table 1: Theory teaching to practical training hours derived from SPPU syllabus (Source: Author)

| Course | No.of Subjects | Lectures in hrs. | Studios in hrs. |
|---|---|---|---|
| Bachelors | | | |
| Ist Year | 7 | 29 | 43 |
| 2nd Year | 7 | 20 | 36 |
| 3rd Year | 7 | 21 | 35 |
| 4th Year | 7 | 20 | 37 |
| Total | | 90 | 151 |
| % to Total | | 37% | 63% |

Table 2 - Detailing of Infrastructure Requirements based on Minimum Standards 2020
*Source: https://coa.gov.in/*
**A. SPACE**

| S. no. | Year of operation | 1st Year | | | 2nd Year | | | 3rd Year | | | 4th Year | | | 5th Year | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Sanction Intake** | **40** | **80** | **120** | **40** | **80** | **120** | **40** | **80** | **120** | **40** | **80** | **120** | **40** | **80** | **120** | |
| | **Activity Space (Carpet Area)** | | | | | | | | | | | | | | | | |
| 1 | Studio-120 sq.m. each | 1 | 2 | 3 | 2 | 4 | 6 | 3 | 6 | 9 | 4 | 8 | 10 | 4 | 8 | 10 | Flexibility in terms of studio spaces can be based on local conditions provided that area of 3 m² per student of sanctioned intake is made available.In case of e- studios. The requirement of the space of such studios may be reduced by 20%. |
| 2 | Class room – 60 sq.m each | 1 | 2 | 3 | 2 | 4 | 6 | 3 | 6 | 8 | 3 | 6 | 9 | 3 | 6 | 8 | Maximum 2 class rooms can be combined together to cater to theory class of maximum 80 students i.e. 120 m². Provided with digital projection facilities and sound amplifier systems |
| 3 | Labs and Workshops– 60 sq.m each | 2 | 2 | 2 | 2 | 3 | 4 | 3 | 4 | 5 | 3 | 4 | 5 | 3 | 4 | 5 | |
| 4 | Computer Centre – 60 sq.m each | - | - | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| 5 | Art Court | - | - | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 80 to 100 sq.m of Semi open / covered area for Display/ working of Painting and Sculpture related activities |

Table 3 -The provision of furniture and equipment for studios as per COA requirement
*Source: https://coa.gov.in*

| D | BOOKS, FURNITURE, EQUIPMENT, COMPUTERS | |
|---|---|---|
| 1 | Titles | 30 |
| 2 | Volumes | 20 |
| 3 | Workstations, and Lockers in studio(Table space for Board + model) Adequacy to be judged by the experts | 15 |
| 4 | Workstations and lockers in faculty room adequacy to be just by the expert | 5 |
| 5 | Lab equipment surveying climatology. | 10 |

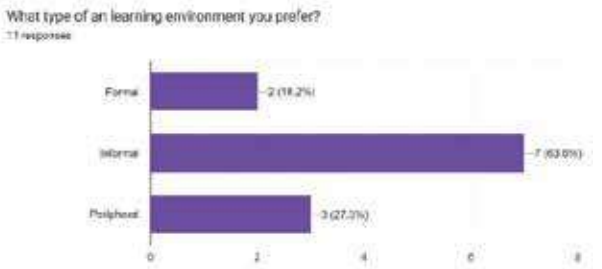


Figure 5: Type of learning environment
*Source: Author*

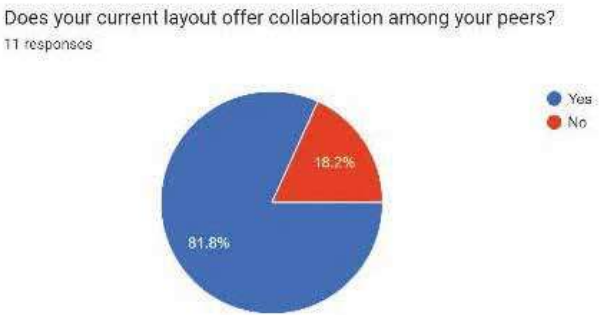


Figure 6: Does current layout offer collaboration
*Source: Author*

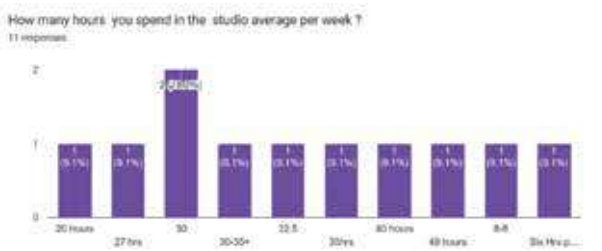


Figure 7: Time spent in studios
*Source: Author*


Figure 8: Need for outdoor spaces attached to studios
*Source: Author*

Figure 9: Hybrid Studio Welsh School of Architecture
*Source: https://www.cardiff.ac.uk/architecture/about-us/facilities/living-lab*

units only. There is a need for electrical points, better WiFi and informal seating. Students spend approximately 30 out of 40 hours in the studio per week (Figure 7). The students expressed the need for an outdoor space attached to the studios for group projects, model making and presentations, as well as for connecting with each other. The outdoor space is also suggested for lunch and informal student engagements (Figure 8).

### 5.2 Case Study 1- Welsh School of Architecture, UK

The Welsh School of Architecture is a preeminent architectural school in Cardiff that sets the global standard. It offers a dynamic, cooperative setting for study and instruction. The school embraces diversity and the multidisciplinary nature of architecture, striving for excellence in research and innovation in teaching and learning across design, the arts, humanities and sciences (Figure 9 and 10).

The provision of a well-equipped hybrid teaching studio with full-height adjustable screens for easy adaptability and acoustically treated walls and ceiling was thoughtfully constructed to provide a flexible teaching space for individual and group lessons, as well as a space for juries to run in parallel. Openable windows and a fan-assisted natural ventilation roof unit were installed to achieve a passive ventilation strategy, thereby contributing to sustainability. The Living Labs were designed as separate rooms to promote and facilitate increased interaction between academics at Cardiff University and other universities, along with businesses, professions and local communities. The two primary features of the Living Lab are its adaptability and accessibility. The LL is an incredibly adaptable area featuring a retractable power outlet, a gridded ceiling to accommodate more installations, top-quality audiovisual equipment and an adjoining observation room. It is the ideal location for mixed-methods research at events requiring a long-term, highly adaptable, self-contained room and antechamber. The Lab is used for environmental and observational investigations, focus groups and interactive seminars. It will continue to play an important role in opening up fresh avenues to increase the impact of our multidisciplinary research.

### 5.2 Case Study 2-Arhaus School of Architecture at Denmark

The Aarhus School of Architecture study is intended to serve as a learning and exploration space for all aspects of architecture LL. The building's raw aesthetic appearance is created from remnants of its industrial past, situated near a former rail yard. The building design is characterised by exposed MEPs and materials as industrial elements, blending in with the run-down surroundings.

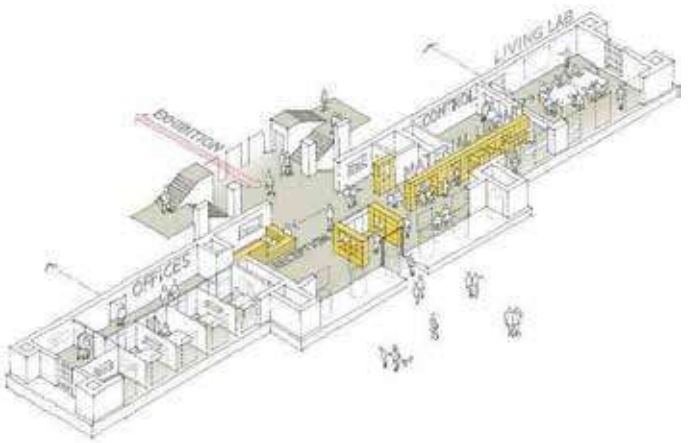


Figure 10: Welsh School of Architecture
*Source: https://www.cardiff.ac.uk/architecture/about-us/facilities/living-lab*

The studio at Aarhus provides students with an ideal setting, with a workspace encompassing requirements for drafting, the use of laptops, space for making models, exposed materials and services, offering a learning laboratory. It also offers students an open outdoor space for interaction and discussion (Figure 11, 12 and 13).

Figure 11: Studio at Aarhaus
*Source: https://www.adept.dk/project/new-aarch*

## 6. CONCLUSIONS AND RECOMMENDATIONS

1. Students should be involved in the process of designing and discussing the layout, thus encouraging cocreation. Architectural studios should incorporate flexible space for design and postproduction, with provisions for drafting units, a well-equipped audiovisual setup, a strong Wi-Fi connection and arrangements for the use of electronic devices such as laptops. They should also provide scope for research and innovation.

Figure 12: Model Making space
*Source: https://www.adept.dk/project/new-aarch*

Figure 13: Outdoor Interactive space
*Source: https://www.adept.dk/project/new-aarch*

2. The studio layout should be large and not restricted to a built form but should accommodate adjacent open spaces and merge with the landscape.
3. The studio acts as a living laboratory by providing space for interaction, encouraging and supporting greater engagement with local communities, industry experts, professionals and fellow academics.

4. The studio location should allow a vertical flow of knowledge among peers, easy access to the library and coffee shop, printing facilities, sufficient space for storing drawings and displaying models.

5. The studio should be naturally lit with provisions for focused lighting. The construction materials of schools should be exposed and unfinished, facilitating a ready palette for learning. All possible services should be kept exposed to ensure the studio functions as a resourceful entity that promotes learning. The integration of the living lab is not confined to a small entity but applies to the entire school and campus.

The provision of the above recommendations will contribute to studios functioning as living laboratories. A further study could be carried out to provide solutions for studio layouts and ways they could be made reconfigurable.

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**Ar. Shital Golhar** is an Associate Professor at D Y Patil School of Architecture, her specialization lies in the field of Digital Architecture. She is a dynamic, determined and focused professional with over 23 years of experience. She is an accomplished academician and practitioner offering Architectural Services.
*Email: golharshital10@gmail.com*

**ARTICLE**

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# Reimagining Urban Spaces

## AI Image Analytics in Barcelona and Amsterdam

**By Ar. R R Govind, Prof. Karthik Mohan and Ar. Sruthi Satheesan**

**Abstract**

Reimagining public spaces requires innovative approaches to tackle the complex challenges of urban living, such as improving infrastructure, ensuring sustainability and enhancing quality of life. This research explores how AI-driven image analytics can transform urban design, drawing lessons from successful projects like Barcelona's Superblocks and Amsterdam's AI initiatives. The study highlights how advanced image processing and machine learning algorithms have reshaped urban planning. For instance, Barcelona's Superblocks model has improved pedestrian-friendliness and reduced traffic congestion, while Amsterdam employs AI for footpath accessibility and rapid urban problem detection using object detection technology. The study aims to illustrate how AI-driven image analytics can improve decision-making, resource management and urban space analysis. By leveraging these technologies, cities can better adapt to the complexities of urban life, promoting sustainable development and improving liveability. The research focuses on practical examples and results rather than technical details, showcasing how AI fosters adaptive urban environments that respond to changing needs.

**Keywords:** artificial intelligence, machine learning, urban challenges, big data

### 1. Introduction

Urban areas are the epicentres of modern society, integrating cultural diversity, economic activity and civic relationships. In the 21st century, digital transformation is redefining human interactions and the way cities function. This integration demands new approaches to urban design and management to build thriving cities for the future. Artificial intelligence (AI) is a key driver of this transformation, offering a paradigm shift in urban planning, development and management by utilising vast datasets and processing power. Its applications range from enhancing energy efficiency and reducing traffic congestion to developing smarter, more adaptable urban ecosystems.

As cities transition from pre-industrial to digital eras, effective urban management becomes critical. Addressing modern urban challenges requires a holistic approach encompassing social, spatial and economic development. AI provides real-time data for adaptive city planning, enabling innovative solutions and fostering responsive, efficient and people-centric urban environments. Integrating geographical and economic development is essential for promoting community growth while ensuring access to essential services like housing, healthcare and education, thereby creating inclusive and prosperous urban environments.

#### 1.1 Aim and Objectives

This study aims to examine how integrating AI into urban design and planning can transform public spaces by exploring the observable changes in urban morphology caused by AI implementation. The primary research question is: What noticeable changes in urban morphology arise from the use of AI in urban design and planning? AI advancements offer new opportunities to address these challenges by providing data-driven insights and predictive capabilities.

Objectives

1. To explore AI's role in optimising urban management and enhancing efficiency.
2. To investigate potential changes in urban morphology facilitated by AI integration.
3. To understand the scope and implications of AI in urban design and planning.
4. To develop a framework for effective AI management in diverse urban contexts.

### 1.2 Scope and Limitation

This study investigates how AI can enhance urban management and design, focusing on its potential to create adaptable urban environments. The research examines AI's relevance in various urban settings, including established and developing areas, drawing insights from case studies. However, as AI is relatively new, the availability of historical data is limited, affecting thorough analysis. A critical aspect of AI's effectiveness is the accuracy and fairness of the data it processes. Biased or incorrect data can lead to errors or biased outcomes in decision-making, posing challenges for its application in urban contexts.

## 2. Literature Review

### 2.1 Defining A City Structure?

Cities are bustling hubs where diverse cultures converge and history meets innovation. However, what exactly defines a city? It is more than just a collection of buildings; it is a complex organism composed of systems and structures that harmonise to create a vibrant whole. Lewis Mumford describes the city as a geographic plexus, an economic organisation and a theatre of social action. He emphasises that cities are not merely built environments but frameworks that foster social networks and significant social dramas.

Urban structure shapes a city's physical, social, economic and cultural dimensions over time, incorporating both historical and contemporary influences. Richard Shearmur underscores the importance of understanding spatial and functional arrangements by integrating social dimensions that define urban life. This approach highlights cities' adaptive complexity, which is vital for managing challenges such as infrastructure decay, social inequalities, environmental issues and land use conflicts, fostering inclusive and resilient communities.

### 2.2 Challenges and Solutions in an Urban Structure?

Urban structure plays a crucial role in fostering community cohesion, operational efficiency and distinct urban identities while improving accessibility and functionality. However, urban frameworks face ongoing issues such as land use conflicts, socioeconomic inequality, environmental degradation and infrastructure pressure. To achieve successful urban management, these challenges must be addressed, aligning with Sustainable Development Goal 11, which focuses on inclusive, resilient and sustainable cities.

Challenges in urban areas span four major dimensions—social, environmental, physical and economic (Figure 1). Tackling these issues requires an integrated approach to ensure equitable development and create vibrant urban environments.


Figure 1: Four aspects of challenges in urban areas
*Source: Author*

Effective solutions for urban infrastructure challenges necessitate multidisciplinary methods that encompass transportation, water supply, sanitation, electricity and housing. Urban planning and design are vital for creating sustainable cities by incorporating green infrastructure, leveraging technology and fostering community participation. Initiatives such as smart urban planning, innovative transport systems, renewable energy integration, public-private partnerships and climate-resilient design aim to build resilient and environmentally responsible urban areas.

### 2.3 Artificial Intelligence: An opportunity for Smart Cities

Smart cities use modern technologies to improve urban living with a focus on efficiency, sustainability and people's quality of life. These cities use networked technology, real-time data and innovative solutions to manage resources, optimise infrastructure and deliver seamless services. Smart cities strive to create more responsive, adaptable and liveable environments by incorporating technology into urban design and management.

Artificial intelligence (AI) is transforming urban design and planning, creating smarter and more sustainable cities. AI uses real-time data and advanced analytics to help urban designers make informed decisions, improving residents' quality of life. With growing computing power and vast amounts of data, AI is advancing rapidly and benefiting cities significantly. AI optimises urban development, infrastructure, services, public administration and citizen participation. It processes large datasets with fast algorithms, enabling machines to learn from patterns and perform human-like tasks (Figure 2).

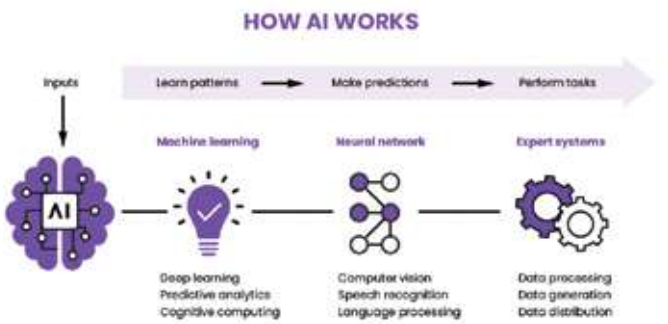


Figure 2: Working of AI
*Source: https://www.weka.io*

Technologies like natural language processing, machine learning and computer vision allow AI to act autonomously and adaptively, overcoming traditional programming limitations.

City planners and governments use AI to enhance traffic management, road safety, water resources, e-mobility and public safety. AI handles traffic, waste and maintenance and predicts energy usage and environmental impacts. It gathers data through digital and mechanical technologies to provide effective solutions. AI's capabilities in speech and audio recognition, image processing, pattern identification and robotics make cities more efficient, sustainable and liveable.

### 2.4 Relevance of AI in Urban Design & Planning

AI provides a revolutionary approach to urban design and planning that takes into account the complexities of city life, including human behaviour, social interactions, politics and the environment. Unlike traditional tools, AI's methodologies (emergent, integrating, generative and augmenting) address the complexities of urban systems. AI may discover new outcomes, seamlessly integrate with existing procedures, develop novel solutions and improve human capabilities.

Spacemaker and other tools use artificial intelligence to optimise urban plans by analysing large amounts of data, rules and environmental conditions. This improves decision-making and efficiency, making AI an essential tool for developing sustainable and habitable urban areas. In urban spaces, AI can improve infrastructure planning, optimise resource use and enhance public amenities, ultimately fostering more resilient and adaptive urban environments.

### 2.5 Major AI components for transforming planning and urban design approach

1. Machine Learning (ML): ML enables systems to self-learn and adapt without explicit programming by processing large amounts of data to reveal patterns and insights. This allows urban designers to automate routine decisions and make data-driven decisions more efficiently.
2. Neural Networks (NNs): NNs, including Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), mimic brain neuron communication to solve complex problems. They enhance data mining and offer deep insights, aiding architects in creating realistic and innovative designs.
3. Deep Learning: As a subset of ML, deep learning uses multi-layered neural networks to process vast data sources, enabling precise predictions and autonomous tasks. It is essential for AI applications in urban design, supporting automation and revealing hidden project goals.
4, Image Analytics: Also known as computer vision, image analytics extracts information from images through AI algorithms. It saves time for urban planners by interpreting diagrams and detecting changes in satellite images, enabling precise measurements and insights that humans might miss.

### 2.6 Urban form analysis through machine learning

Urban form analysis involves understanding a city's physical characteristics and their complex relationships. Integrating AI enhances this process through three key steps (Figure 3):


Figure 3: Steps involved in Urban Form analysis through ML
*Source: Author*

1. Creating a Custom Form Dataset: Collect and organise detailed data about the urban environment.

2. Identification of Urban Types: Use machine learning to classify different urban forms based on shapes and patterns.
3. Evaluating Inductively Defined Urban Types: Assess the identified types to understand their implications and relationships within the urban context.

## 3. Methodology

To explore the possibilities of AI in reimagining urban spaces, the cases of Barcelona and Amsterdam were studied. The relevance of AI in urban management was first understood to guide the research and formulate clear aims and objectives.

A comprehensive background study was then conducted to gain insights into the core elements of urban spaces. This involved examining what constitutes a city, its structure and the interplay of its various components. Common challenges faced by urban areas were identified and potential solutions were explored, with a particular focus on how technology, especially AI, contributes to building better cities and urban spaces.

Through an extensive literature review, a deeper understanding of the city, its structure and the challenges and solutions that can arise was achieved. The benefits of AI to smart cities, its relevance and the steps involved in analysing an urban space using AI were studied. This background study set the stage for examining the specific cases of Barcelona's Superblock and Amsterdam's urban strategies.

By analysing these cases, a basic understanding of the various parameters and tools used in these cities was gained. This knowledge could then be applied to enhance urban spaces in India and other parts of the world, providing a framework for using AI to create smarter, more sustainable cities (Figure 4).

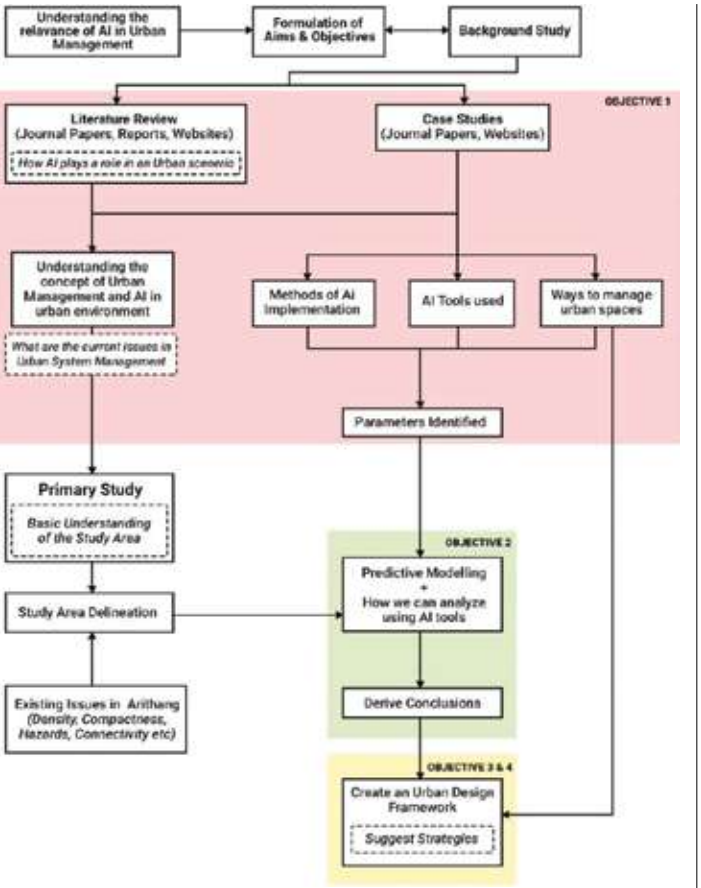


Figure 4: Methodology
*Source: Author*



Figure 5: Ariel View of Barcelona City with street network
*Source: https://www.archdaily.com*

## 4. Data Analysis and Findings

### 4.1 The Case of 'Barcelona Superblock'

#### 4.1.1 'Barcelona Superblock'

Barcelona is the capital of Catalonia, Spain's autonomous community and the country's second-largest city. Nonetheless, Barcelona is now among the most polluted cities in Europe. This is mainly due to its topography, high traffic density, which is four times higher than that of London, and a huge proportion of diesel-powered vehicles, now 50%.

To reverse this trend, in 2016, Barcelona introduced a new urban planning model called the Superblock (Figure 5). The goal is to reclaim public space for people, minimise motorised traffic, promote sustainable mobility and active lifestyles, provide urban greening and limit the impact of climate change (Figure 6). However, several researchers have highlighted the absence of a comprehensive evaluation of the potential and measurable effects of implementing the Superblock design on a city-wide scale. This planning strategy poses a danger to the

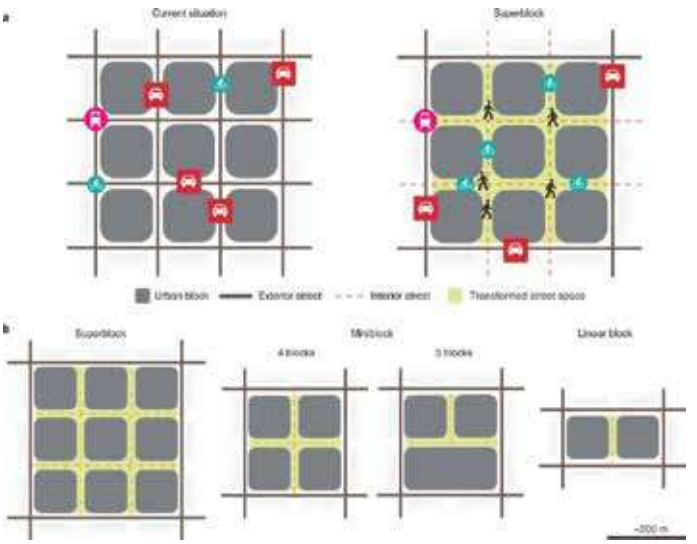

Figure 6: Schematic Working of superblock design
*Source: https://www.nature.com/articles/s41893-022-00855-2*

urban fabric as a programmable surface, regulating access to cars and vehicles in public streets while enabling the extension of walkable areas and cycling paths. As urban strategies evolve, new data-driven tools emerge to inform spatial design.

4.1.2 Analysing 'Superblocks' Using Artificial Intelligence

Ar. Aldo Sollazzo, CEO of 'Noumena', specialises in data-driven spatial analytics and directs IAAC Barcelona's Master of Robotics and Advanced Construction programme. His work focuses on using computer vision and machine learning algorithms to analyse image-based data, generate metrics for spatial transformations and estimate $CO_2$ emissions in urban environments (Figure 7). This approach aligns with leveraging technology to tackle urban challenges like traffic congestion and environmental quality, particularly addressing Barcelona's limited green spaces compared to cities such as London and Amsterdam.

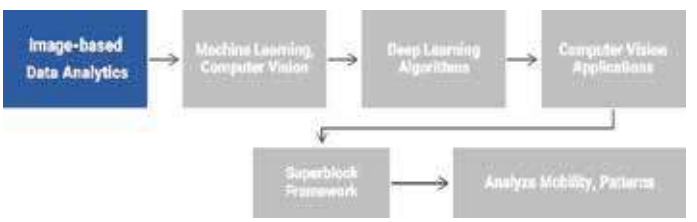


Figure 7: Process of Analysing Data
*Source: Author*

Urban informatics, a key domain in big data research, explores urban processes using diverse data sources. It encompasses strategies for dynamic resource management, theoretical insights, civic engagement and urban planning advancements. Data sources are categorised into structured (well-defined format) and unstructured (textual, visual) types, with image-based data analytics playing an increasingly vital role. Machine learning and computer vision algorithms enable applications in spatial analytics, influencing architecture and urban design by enhancing interactions between occupants and space. These technologies are pivotal in improving the accessibility, safety and functionality of public spaces, supporting diverse community activities and urban lifestyles.

Image analytics leverages computer vision and machine learning to detect spatial dynamics and movements of objects in varying conditions. While computer vision detects movements, machine learning enhances accuracy, especially in changing light conditions. In Barcelona, different algorithms are being tested to analyse pedestrian movement within the Superblock. Object detection algorithms like YOLOv4, MobileNet SSD and FairMOT are employed, each offering unique capabilities in real-time object detection and tracking (Figure 8).

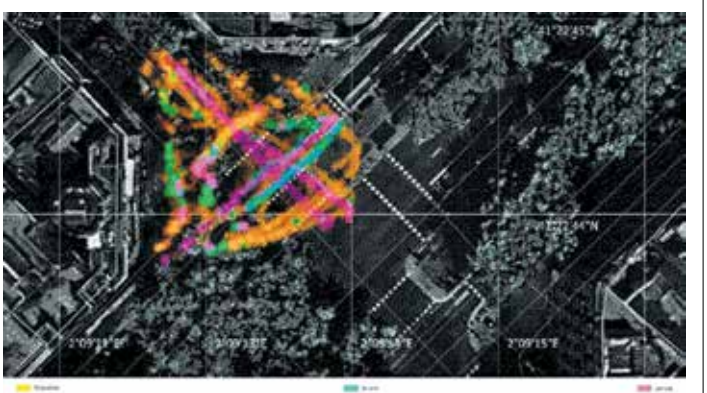

Figure 8: Image Analytics using SSD in Barcelona
*Source: Noumena*

These algorithms are assessed using metrics like Intersection Over Union (IoU), where FairMOT demonstrates superior performance in spatial dynamics and tracking accuracy compared to YOLO and MobileNet SSD. This technological integration highlights AI's role in urban planning and public space enhancement, demonstrating its potential to foster safer and more responsive urban environments.

4.1.3 Analysis

Technology, especially AI-powered solutions, plays a crucial role in addressing complex urban challenges, notably in Barcelona. This case underscores the significance of technology in urban planning, resource management and enhancing public spaces through Urban Informatics. Machine learning and computer vision are pivotal in driving spatial transformations

by enabling deeper insights into occupant-space interactions. Object identification algorithms are integral to this technological framework, although their performance varies across different detectors. This integration highlights how advanced algorithms and data-driven insights contribute to smarter, safer and more responsive urban environments. Barcelona's projects exemplify this integration, showcasing innovative solutions that prioritise the well-being and functionality of public spaces.

### 4,2 The Case of Amsterdam

4,2,1 'Amsterdam Intelligence'

Amsterdam, the capital and largest city of the Netherlands, serves as the nation's primary commercial and financial hub. Recognised as a "digital frontier" city, Amsterdam pioneers the use of AI in urban planning and sustainability initiatives. AI algorithms are deployed to analyse traffic, optimise public transport routes and reduce energy consumption in buildings, positioning Amsterdam at the forefront of smart urban management. The city's municipal government supports innovation and sustainability, fostering a conducive environment for smart city development under initiatives like "Amsterdam Intelligence". These efforts aim to tackle urban challenges and enhance the city's overall liveability, including measures like establishing environmental zones and deploying smart roadside cameras for managing vehicle emissions effectively. Machine learning assists in identifying types of waste and continuously assessing cleanliness levels in real time. Additionally, a digital taxi steward application ensures high standards in taxi services, while predictive models powered by data analysis help prevent illegal housing and fraudulent activities. These measures optimise tasks such as traffic flow, cleaning and safety. The city also explores innovative chatbot solutions like Goochem, recommending cultural activities, and the City's Service and Facility Management department experiments with its chatbot. Amsterdam's wide-ranging technological integration exemplifies its dedication to using innovation for the betterment of urban life. (Figure 9)

One example is 'Determining Accessible Sidewalk Width by Extracting Obstacle Information from Point Clouds'. The case study delves into the complexities of sidewalk accessibility in Amsterdam, specifically addressing challenges faced by individuals using mobility devices. The primary objective is to employ advanced 3D point cloud technology to identify and quantify obstacles that impede pedestrian movement. This innovative approach contrasts with traditional methods by providing precise


Figure 9: 'Garbage' detection in Amsterdam City.
*Source: Agenda AI: Amsterdam Intelligence, https://amsterdamintelligence.com/*

measurements of obstacles such as bushes and overhanging structures that are often overlooked in municipal records. The information gathered can be crucial for people using the sidewalks and for decision-makers in the city. The figure illustrates key concepts for accessible movement on pavements. The effective manoeuvring area (yellow) is the minimum width for individuals to pass. It should be narrower than the sidewalk width without obstacles (purple). The total sidewalk width (green) represents the width excluding obstacles. Policy criteria mandate a minimum width of 0.9 metres for mobility device users, 1.8 metres for accommodating pedestrians and mobility devices and 2.9 metres for high pedestrian traffic. (Figure 10)

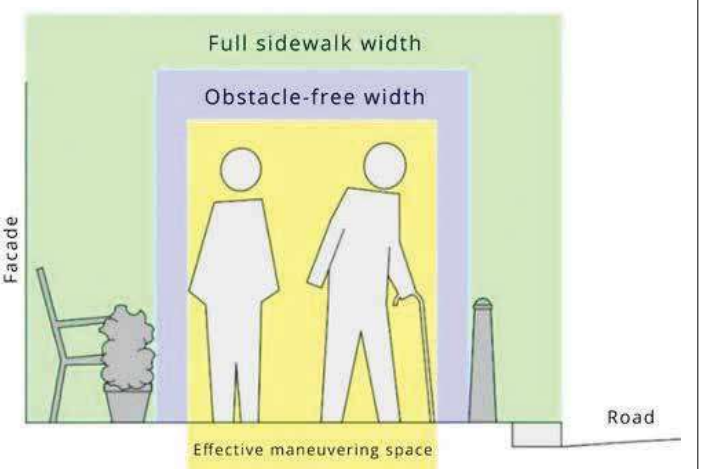


Figure 10: Image showing complete pavement width in green and obstacle-free width in purple.
*Source: Journal on Extracting Obstacle Information from Point Clouds*

The methodology begins with sourcing topographical data from municipal registries to establish baseline sidewalk dimensions and identifying large-scale static objects. Complementing this, point cloud data collected via LIDAR scanners from CycloMedia

offers detailed street-level 3D information crucial for mapping smaller obstacles and verifying municipal data accuracy, particularly in areas involving private properties. Key to the process is the extraction of obstacle data through a change detection algorithm that compares multiple scans over time to differentiate between static and temporary obstructions. This data is then projected into 2D polygons, allowing for a comprehensive visualisation of obstacles like terraces and tree beds that affect sidewalk accessibility (Figure 11).

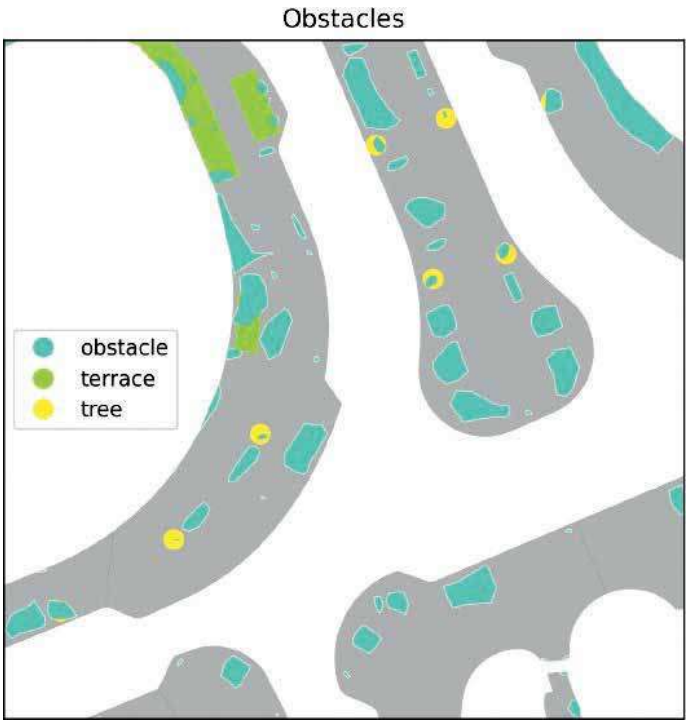


Figure 11: 2D polygons generated from the obstacles in the point cloud (blue), along with terraces (green) and trees (yellow)
*Source: Journal on Extracting Obstacle Information from Point Clouds*

Once obstacles are identified, the next step involves calculating both the total sidewalk width and the obstacle-free width using methods similar to those employed in projects like Sidewalk Widths NYC. This meticulous calculation aids in understanding where sidewalk widths fall short of accessibility standards, such as the minimum width required for mobility device users or pedestrians.

Validation of findings is crucial and is conducted through a combination of digital tools like Google Maps for virtual measurements and physical inspections at various city locations. These validations revealed discrepancies between recorded widths in municipal databases and actual obstacle-free widths observed on-site. For instance, a significant percentage of sidewalks recorded as wide in the database were found to be obstructed when measured in reality, highlighting the limitations of relying solely on static data for urban planning.

## 5. Results and Discussion

### *Barcelona Superblock Study*

The Barcelona Superblock programme is a groundbreaking urban planning technique aimed at generating healthier and safer urban environments. The study assessed urban models using machine learning approaches to develop data-driven criteria based on observations of public areas. Key findings show that AI-powered systems can successfully analyse spatial dynamics and monitor carbon emissions, emphasising its potential for urban sustainability efforts. However, the rapid evolution of technology requires continuous advancements to provide more effective and efficient solutions. Calibration within legal and administrative frameworks is critical for protecting privacy, ethical norms and citizen engagement in urban planning processes.

### *Accessible Sidewalk Width Estimation, Amsterdam*

Researchers have developed a method to estimate accessible sidewalk width using point cloud data and topographical maps. They found large discrepancies between full and obstacle-free widths, highlighting the importance of this information for policy-making and navigation. Future work aims to reduce “unknown widths” and improve accuracy in dealing with bridges, square entrances, parked bicycles and plant seasonality. The map will include features like kerb heights, ramps, crosswalks and public transport stops and will be used as a local route planner for people with reduced mobility.

The aim of this study was to investigate and evaluate innovative methods for reimagining urban spaces through advanced AI techniques and real-time data systems. Both the Barcelona Superblock study and the sidewalk width estimation method highlight how technological advancements can revolutionise urban planning and management. The Barcelona Superblock project highlights the importance of machine learning in improving urban liveability by optimising public space use while limiting environmental externalities. AI-driven spatial analysis and carbon monitoring provide major environmental benefits, allowing cities to better address urban concerns and improve citizens’ quality of life. This concept demonstrates how technology may transform urban surroundings to be more efficient and responsive to changing demands. Similarly, the sidewalk width estimation method underscores the importance of precise data in improving urban mobility and accessibility. By detecting disparities between full and obstacle-free widths, the study emphasises the importance of precise measurements in urban planning and policy decisions. The development of a comprehensive

map with additional features will further support the creation of inclusive and accessible public spaces.

These studies demonstrate the enormous potential of combining AI-driven methodologies with reliable data analysis in urban management. Such innovations help create more sustainable, efficient and inclusive urban environments. Continuous research and innovation are critical for addressing urban challenges and promoting smart city efforts, resulting in a higher quality of life and functionality in urban spaces.

Various papers were reviewed, from which parameters and AI tools were identified. The studies underscore AI's crucial role in urban transformation, advocating for its integration to overcome challenges and unlock new opportunities. The focus is on developing responsible and adaptable AI systems that foster innovative, sustainable and human-centric urban environments. Overall, the research highlights AI's potential to enhance urban design and management, addressing both global issues and community-specific needs.

Parameters Identified

The various parameters identified are (Table 1):

Identified AI tools (Table 2)

Table 1: Parameters Identified
*Source: Author*

| Paper | Parameters Identified | |
|---|---|---|
| | **Macro-level Parameters** | **Micro-level Sub-parameters** |
| Artificial Intelligence in Urban Development: Opportunities, challenges and ideas for the German Development Cooperation | **Urban Infrastructure** | Urban Planning, Mobility, Energy Infrastructure, Water, Waste Systems, Construction, Flash Flooding, Landslides Challenges, Internet Provision, Cyber-Security, Surveillance, Education Sector, Safety, Census Data, Air Pollution Measurements, Climate and Weather Data, Movement Patterns for Public Transport, Localisation and Movement Data, Traffic Surveillance Data, Images, Speech Data, Opinions, Pictures of Current Events, Traffic Surveillance Data, Movement Patterns for Public Transport |
| | Digital Infrastructure | |
| | Public Services | |
| | Data Collection and Analysis | |
| | Environmental Factors | |
| | Safety and Security | |
| | Public Opinion and Interaction | |
| | Utility Services | |
| | **Traffic Management** | |
| | Financial Services | |
| | Citizen Engagement | |
| The Future of Urban AI: Global Dialogues on Urban Artificial Intelligence | Urban Planning | Transport Network, Physical Assets, Infrastructure Rehabilitation and Improvement Efforts, Public Services, Norms and Regulation, Scalability, Spatiality, Ecology, Water Consumption, Urban Biodiversity, Human-centric Approach, Spatial Pattern, Behavioural Pattern |
| | Environmental Sustainability | |
| | Governance | |
| | **Liveability** | |
| | Societal Harmony | |
| | Technological Infrastructure | |
| | Privacy | |
| | **Spatial Analysis and Patterns** | |

Table 2: Identified AI tools
*Source: Author*

| Purpose | AI Tools |
|---|---|
| Planning urban infrastructure using GIS, demographic and transportation data to model and simulate urban systems | **CAST, CityGPT** |
| Desired key behaviours and train the machine to design an optimized solution within an urban system | **MIT Urban Risk Lab** |
| Generate high-quality images from textual descriptions(Generative AI) and analyse images | *Generative AI tools:* **DALL-E, Midjourney, Stable Diffusion** |
| For other Deep Learning Exercises for object identification and data analysing using CNN networks | **YOLOv4, Object Detection Kit, Point Clouds, MobileNet v2, FairMOT MIT Places365** |

## 6. Conclusions and Recommendations

In conclusion, the transformative potential of AI in urban management is evident from the studies conducted in Barcelona and Amsterdam. Barcelona's Superblock initiative demonstrates how AI can optimise public space usage and enhance urban sustainability by analysing spatial dynamics and carbon emissions. Similarly, Amsterdam's methods for estimating sidewalk accessibility using point cloud data highlight the importance of precise measurements in improving urban mobility and inclusivity. AI offers unprecedented opportunities to reshape urban form, optimise sustainability and enhance liveability.

Integrating AI technologies into urban planning can lead to more efficient, inclusive and responsive urban spaces. The following framework provides guidelines for harnessing AI's potential in urban design:

1. Spatial Analysis & Patterns

- Utilise AI for land use and urban morphology analysis.
- Identify spatial constraints and opportunities for design interventions.
- Detect emerging patterns to inform innovative urban solutions.

2. Public Spaces Enhancement

- Enhance public spaces with AI-driven user behaviour analysis.
- Design inclusive, vibrant areas based on predictive models.
- Optimise space layout and amenities for improved social interaction.

3. Built Spaces Optimisation

- Develop software for exploring and selecting optimal building designs.
- Apply generative algorithms to optimise layouts, façades and energy performance.
- Integrate AI for indoor environmental management and advanced energy modelling.

4. Connectivity Enhancement

- Improve urban mobility with AI-powered traffic management and smart transport solutions.
- Design pedestrian-friendly environments and efficient transportation networks.
- Enhance digital infrastructure for better connectivity and accessibility.

5. Environmental Sustainability Integration

- Integrate sustainability principles through AI-driven impact assessments.
- Design climate-responsive landscapes with predictive risk modelling.
- Implement green infrastructure and monitor vegetation for urban greening.

These guidelines aim to address complex urban challenges and support the development of smart, sustainable and equitable urban spaces. The integration of AI technologies will be crucial in advancing urban management and ensuring cities are more adaptable, efficient and inclusive (Figure 12).


Figure 12: Scope for the Framework
*Source: Author*

Given the different scopes, it is evident that AI has the potential for application throughout urban contexts, although adaptation is required for particular tasks within each setting. Therefore, developing a general framework for AI-induced urban design would need to take these variations into account and adapt solutions accordingly. The applicability can begin from selecting the most suitable site to obtaining the final end product.

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**Ar. R R Govind** (A24900), partner at BYT Architects, Trivandrum, is an Architect and Urban Designer with four years of experience. Passionate about livable cities, he blends Kerala's heritage with contemporary design. He holds an M.Arch. (Urban Design) from CET and a B.Arch. from Marian College, Thiruvananthapuram.
*Email: ar.govindrr@gmail.com*

**Prof. Karthik Mohan** (A19070), Assistant Professor at CET, Thiruvananthapuram, has over 20 years of experience in architecture and teaching. He is also a FLAIR International Fellow with International Internship experience at Arts University Bournemouth, UK. He earned his B.Arch from CET *and M.Arch (First Rank) from IIT Roorkee, now pursuing a PhD.*
*Email: karthik@cet.ac.in*

**Ar. Sruthi Satheesan**, an Urban Designer and Ad-hoc Assistant Professor at CET, Thiruvananthapuram, specialises in architectural education, research, and design policy. A CET graduate, she mentors students, guides research, and contributes to Kerala's design policy, focusing on high-quality souvenirs inspired by the state's rich arts and crafts heritage.
*Email: sruthisatheesan@cet.ac.in*

ARTICLE

# Development on Reclaimed Land

By Krishna Sahani and Dr. Venkata Krishna Kumar Sadhu

**Introduction to Land Reclamation for Development**
Land reclamation involves creating new land from oceans, seas, riverbeds, or other water bodies, primarily by filling or dredging. It has become an increasingly common strategy for housing development in densely populated regions with limited land availability.

In many urban centres, especially in coastal areas, rapid population growth, urbanisation, and economic expansion have led to land shortages and high property prices. As a result, reclaiming land offers a solution to provide additional space for housing, infrastructure, and commercial developments. Countries like the Netherlands, Japan, and Singapore have successfully used land reclamation to expand their cities.

Reclaimed land for development allows cities to accommodate growing populations without expanding into ecologically sensitive areas inland. However, it comes with challenges such as environmental concerns, high costs, and long-term sustainability issues. In India, land reclamation has the potential to address the housing needs in cities like Mumbai, where space is severely limited, but it requires careful planning to balance urban growth with environmental preservation and social equity.

Development on reclaimed land involves the construction of residential areas on land that has been artificially created, typically from bodies of water such as seas, rivers, or lakes. This process is common in areas where there is a high demand for land but limited availability of natural land. Here is how it typically works:

**Key Aspects of Development on Reclaimed Land**

1. Reclamation Process: Land reclamation involves filling water bodies with materials like sand, rocks, or soil to create new land. The process can also involve draining wetlands or marshes. Engineering techniques like dykes and levees may be used to hold back water and prevent flooding.
2. Environmental Considerations: Reclaiming land can have significant environmental impacts. It can disrupt local ecosystems, marine life, and water quality. Careful planning and environmental impact assessments are needed to minimise these effects.
3. Infrastructure and Engineering Challenges: The reclaimed land may require extra infrastructure support, such as water management systems, drainage, and soil stabilisation, because it may be more prone to flooding or soil settlement. Modern engineering solutions like geotextiles and foundation piles are used to strengthen the land for development.
4. Urban Development: Reclaimed land is often used for high-density housing projects, especially in areas with high population pressures like coastal cities. Countries like the Netherlands, Singapore, and Japan are famous for using reclaimed land for urban development.
5. Sustainability Considerations: Newer developments focus on sustainable practices, such as creating green spaces, using eco-friendly materials, and integrating renewable energy sources to ensure that reclaimed land is both environmentally and socially sustainable.
6. Economic and Social Benefits: Development on reclaimed land can increase land availability, particularly in urban centers, potentially reducing housing shortages. It also drives economic growth by opening new areas for commercial and residential development.

Development on reclaimed land requires specialised construction methods to ensure the stability and durability of structures. The main challenge is building

on land that may have unstable soil or be prone to water intrusion. Below are common construction methods and techniques used for development on reclaimed land:

1. Land Reclamation Techniques
    - Hydraulic Fill Method: This is the most common technique, where sand, gravel, or other materials are dredged from nearby water bodies and pumped onto the reclamation site. The material is spread and compacted to form a stable foundation.
    - Dry Fill Method: In areas with shallow waters, the dry fill method is used, where land is extended by dumping soil, rocks, or construction debris without the use of water.
    - Vertical Drains and Preloading: To speed up the consolidation of soft soils, vertical drains are installed. Preloading involves placing temporary weight (soil or water) on the reclaimed land to squeeze water out of the soil and make it denser.
2. Soil Stabilisation
    - Compaction: Once the land is reclaimed, soil compaction is critical to improve its load-bearing capacity. Heavy machinery, such as rollers or compactors, is used to compress the soil and remove air gaps.
    - Vibro-Compaction: For sandy reclaimed land, vibro-compaction is a technique that densifies the soil by inserting a vibrating probe deep into the ground. This causes the soil particles to rearrange and compact.
    - Soil Improvement Methods: In some cases, the reclaimed soil may be soft or clayey. Techniques like stone columns, deep soil mixing (DSM), or cement stabilisation can improve the soil's strength and stability.
3. Foundation Construction
    - Piling: Foundations for buildings on reclaimed land often require piling, where deep foundations are created by driving steel, concrete, or timber piles into the ground to reach a stable layer of soil or bedrock. This prevents settlement or shifting of the building.
    - Floating Foundation: In areas where the soil is weak or highly compressible, floating foundations, also known as raft foundations, can be used. This involves creating a large, solid platform that "floats" on the soft soil, distributing the building's weight evenly.
4. Water Management Systems
    - Drainage Systems: Effective drainage is essential on reclaimed land to prevent flooding or waterlogging. Subsurface drainage systems, canals, or stormwater retention ponds may be built to manage excess water.
    - Waterproofing and Flood Protection: Buildings on reclaimed land often require enhanced waterproofing measures, especially for basements or underground structures. Flood protection methods like levees, sea walls, and elevated building designs can also be employed in coastal areas.
5. Building Design Considerations
    - Seismic-Resistant Design: In regions prone to earthquakes, special design measures are necessary. Flexible materials and dampers that absorb seismic energy may be incorporated into the building structure.
    - Load Distribution: On reclaimed land, engineers must ensure that buildings are designed to evenly distribute loads to prevent uneven settlement. Tall buildings may require additional deep piling and foundation work to stabilise their weight.
6. Sustainable Practices
    - Green Building Materials: Sustainable construction techniques involve using eco-friendly and recycled materials for development on reclaimed land. This helps reduce the environmental footprint of the project.
    - Energy Efficiency and Landscaping: Integrating green spaces, energy-efficient designs, and renewable energy sources (like solar panels) can make developments on reclaimed land more environmentally sustainable.
7. Monitoring and Maintenance
    - Settlement Monitoring: Even after construction, reclaimed land can continue to settle. Long-term monitoring is necessary to detect any uneven settlement and make adjustments, if necessary. Ground sensors and settlement markers can be used for this purpose.

- Maintenance of Flood Defences: Dykes, sea walls, and drainage systems must be regularly maintained to ensure they function effectively and protect the development from potential water damage.

**Methods of Land Reclamation:**
There are four methods in which land reclamation processes are carried out. The method chosen depends on a variety of factors like type of land, the availability of material to be filled, foundation of soil, topography of waterbed etc.

1. Dry Method: This is the simplest method of land reclamation. Here the required area is filled with large and heavy rocks or with cement. Then the land is built up to the required height by using clay or soil.
2. Hydraulic Reclamation Method: In this method a bottom opening barrage carries fill material from the offshore borrow source and dumps it at the appropriate location. It is a wet method wherein the soil must have good drainage characteristics.
3. Rehandling Method: Here barrages are used to transport and then dump fill materials into a temporary storage pit. The rehandling has a capacity of several million cubic meter.
4. Sand Spreading Method: When there is a shallow seabed or the seabed is too soft for hydraulic filling this method can be used. A spreader can be mounted on a floating barrage and sand is discharged along the water through a pipe.

**Impact of Natural Forces**
Natural forces, such as waves, tides, surges, erosion, and deposition, can impact land reclamation in a number of ways.

Soil liquefaction: Reclaimed land can be prone to soil liquefaction during earthquakes, which can damage buildings and infrastructure.

Subsidence: Reclaimed land can sink due to soil compaction or when wetlands are drained and enclosed by levees.

Rising sea levels: Reclaimed coastal lands are threatened by rising sea levels. For example, Incheon International Airport in South Korea has sunk by 28.5 cm per year.

When it comes to constructing on water there are various natural forces that need to be kept in mind like freak waves, earthquakes, erosion and even the one in 1000-year storm. The area constructed must be able to withstand even the worst-case scenario. Keeping this in mind there are two main things which the engineers and designers have to keep in consideration: the surrounding ocean or the sea and earthquakes.

**Need for land Reclamation**
Artificial islands for development are becoming an increasingly important consideration in India for several key reasons:

1. Population Pressure and Urbanisation: India's population is over 1.4 billion, with rapid urbanisation putting immense pressure on land resources in major cities like Mumbai, Delhi, and Bangalore. The demand for affordable housing and infrastructure far exceeds available land, especially in coastal regions. Artificial islands can provide a solution to alleviate this land scarcity by creating new, usable space in areas with limited land. See Figure 1.

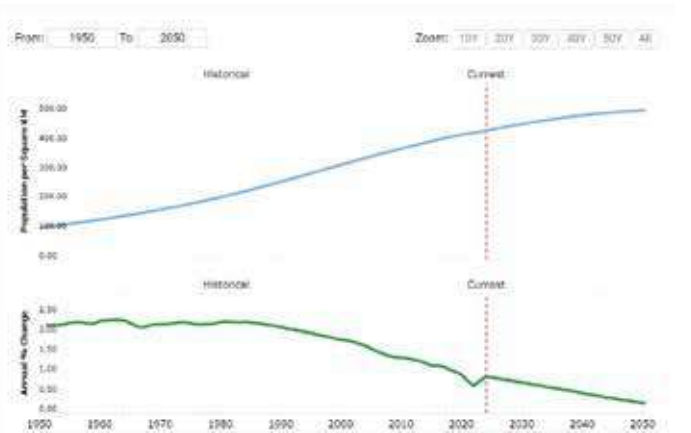


Figure 1: Population pressure and urbanisation / A densely populated cityscape illustrating urban expansion and congestion
*Source: www.worldbank.org*

2. Rising Sea Levels and Climate Change: Coastal cities in India are at risk due to rising sea levels caused by climate change. Constructing artificial islands with advanced engineering techniques can create elevated land masses, mitigating the risk of flooding and allowing for more climate-resilient housing and infrastructure. These islands can be designed with sustainability and environmental concerns in mind.
3. Tourism and Economic Growth: Artificial islands can attract tourism and business investment by offering unique, high-value real estate and hospitality projects. The success of Dubai's Palm Jumeirah and other artificial islands globally shows that these projects can be lucrative in terms of tourism, trade, and business. India's coastline, especially around Mumbai, Goa, and Kerala, holds similar potential for development.

4. Innovative Solutions to Land Shortage: Cities like Mumbai are heavily congested, with little scope for horizontal expansion. Building vertically or reclaiming land from the sea (through artificial islands) could provide the much-needed relief for housing, transportation, and infrastructure. Artificial islands offer an innovative way to expand housing stock without displacing people from inland areas.
5. Sustainable Development Potential: Properly designed artificial islands can incorporate eco-friendly technologies, such as renewable energy, waste management systems, and sustainable water practices. This can provide a model for future urban development projects that minimise environmental impact and contribute to a greener housing solution in India.
6. Strategic Infrastructure and Security: Artificial islands can also serve strategic purposes, such as enhancing maritime security and creating new trade hubs. Housing on artificial islands could be integrated with infrastructure that supports India's strategic interests, especially in coastal regions that are key to the country's defence and trade.

In summary, artificial islands can address India's pressing needs for more housing, provide climate resilience, drive economic growth, and offer innovative solutions to land scarcity.

**Challenges**

Building artificial islands for development in India comes with several significant challenges. These range from environmental and financial issues to legal and technical hurdles. Here are the key challenges:

1. Environmental Impact:
    - Marine Ecosystem Disruption: The construction of artificial islands can lead to severe disruption of marine life, coral reefs, and coastal ecosystems. Dredging and land reclamation processes may destroy habitats, impact fisheries, and harm biodiversity.
    - Coastal Erosion and Sedimentation: Artificial islands may alter natural tidal patterns, causing erosion in other coastal areas. This can have unintended effects on nearby landmasses, leading to further environmental degradation.
    - Climate Change and Sustainability: Building artificial islands in an era of rising sea levels may seem counterproductive. There's a risk that these islands could eventually be submerged, despite being designed to counteract flooding.
2. High Costs and Economic Viability:
    - Enormous Construction Costs: The engineering and construction of artificial islands require massive financial investments, both in terms of materials and technology. Advanced dredging, soil stabilisation, and building infrastructure on reclaimed land can be prohibitively expensive.
    - Ongoing Maintenance Costs: Artificial islands require long-term maintenance, including protection against erosion, land subsidence, and storm surges. This adds to the cost, making it less attractive for affordable housing projects.
3. Legal and Regulatory Issues:
    - Ownership and Jurisdiction: Defining the ownership of land created offshore presents legal complexities. Artificial islands are not part of the natural coastline, so questions regarding land rights, taxation, and jurisdiction can arise.
    - Environmental Regulations: India has strict coastal zone regulations (e.g., Coastal Regulation Zone (CRZ) rules) aimed at protecting marine and coastal ecosystems. Securing permissions and ensuring compliance with these regulations can be a lengthy and complex process.
    - Public Opposition: Local populations, environmentalists, and fishing communities may oppose artificial island projects, especially if they threaten livelihoods or degrade natural ecosystems.
4. Technological and Engineering Challenges:
    - Soil Stability: Building on reclaimed land in coastal areas involves challenges related to soil stability. Engineering solutions are required to ensure that the island remains stable and resilient to both environmental factors and the weight of large structures.
    - Natural Disasters: India is prone to cyclones, tsunamis, and earthquakes, especially in coastal regions. Designing artificial islands to withstand these natural disasters requires cutting-edge technology and planning, which can significantly increase construction time and costs. (Figure 2)

Figure 2: An image depicting the aftermath of a natural disaster in an urban setting.
*Source: freepic*

- Infrastructure Connectivity: Islands need to be connected to the mainland for utilities, transportation, and services. Building bridges, tunnels, or ferries, along with setting up reliable water, electricity, and sewage systems, is technically challenging and expensive.

5. Social and Housing Issues:
   - Affordable Housing vs. Luxury Projects: Artificial islands are often used for high-end residential and commercial projects, as seen in Dubai's Palm Islands. The challenge in India is whether these projects can serve the general population's housing needs, especially for affordable housing, or if they will primarily cater to the wealthy. (Figure 3)

Figure 3: A contrast between high-rise luxury apartments and low-income housing settlements.
*Source: istock*

- Displacement and Land Use Conflicts: There is potential conflict over land use, especially if the artificial island projects take away fishing zones or coastal resources traditionally used by local communities.

6. Time and Bureaucracy:
   - Long Project Timelines: Constructing artificial islands can take decades, from planning and regulatory approvals to execution. This may not be an immediate solution for India's urgent housing crisis.
   - Bureaucratic Red Tape: Navigating through India's bureaucratic processes for approvals, environmental clearances, and securing funding can be slow and challenging. The delays in project implementation could drive up costs and make the entire venture less feasible.
7. Geopolitical Concerns:
   - Strategic and Security Issues: Given India's strategic location, building artificial islands near coastal areas may raise security concerns. Neighbouring countries or defence agencies might scrutinise these developments due to the potential military or trade implications.
8. Water and Resource Management:
   - Water Supply and Waste Management: Providing adequate freshwater supplies and sustainable waste management systems on artificial islands is a major challenge, particularly for large populations. Islands far from the mainland may require desalination plants or long-distance pipelines, both of which are costly.
   - Energy Requirements: Ensuring a reliable and sustainable power supply to artificial islands can be difficult. Renewable energy options may be viable, but they require substantial investment in infrastructure.

**Social Challenges**

In conclusion, while artificial islands for housing could offer some solutions to land shortages in India, the challenges are significant, particularly in terms of environmental sustainability, high costs, regulatory hurdles, and the ability to serve the broader population's housing needs.

he construction of artificial islands for housing in India could have significant social effects:

- Impact on Local Communities: Coastal communities, particularly fishing populations, might be displaced, leading to economic and cultural disruptions. Long-standing traditions linked to the sea could be lost.

- Housing Inequality: Artificial islands often cater to luxury housing, which could increase inequality and worsen housing affordability for middle- and lower-income groups.
- Urban-Rural Divide: These projects may further concentrate wealth in cities, drawing more migration and widening the gap between urban and rural areas.
- Job Creation: While these islands would create jobs in construction, tourism, and services, their economic benefits might not reach everyone, especially the displaced communities.
- Social Exclusion: Artificial islands may become exclusive, gated communities for the wealthy, deepening socio-economic divides.
- Infrastructure Strain: These developments would place additional pressure on urban services like water, electricity, and transportation, potentially overburdening nearby cities.
- Social Segregation: Islands could increase physical and social separation between affluent residents and the mainland population, affecting community cohesion.
- Changing Social Norms: The rise of luxury developments could shift lifestyle aspirations, promoting consumerism and individualism.
- Public Access and Land Rights: Access to coastal areas might be restricted, and land rights disputes could arise, impacting local populations.
- Social Tensions: Protests and conflicts over environmental damage, displacement, and loss of livelihoods may arise as communities push back against these projects.
- Cultural Shifts: The influx of urbanisation, tourism, and Western influences could alter local cultures, potentially eroding traditional ways of life.

While artificial islands could alleviate urban housing pressures and create economic opportunities, they also raise significant concerns around inequality, displacement, and social exclusion. Careful planning and inclusive policies would be essential to mitigate these challenges.

**Future cities may adopt land reclamation for housing**

India's future city targets for artificial islands, particularly for housing, are focused on addressing land scarcity, population growth, and urban development challenges. Key cities like **Mumbai, Chennai, Goa, Kochi**, and others are potential candidates for such projects.

1. Mumbai – Housing and Urban Expansion
   - Vision: Create sustainable housing and commercial spaces on artificial islands to relieve pressure on congested urban areas.
   - Goals: Alleviate housing shortages, develop climate-resilient infrastructure, and support affordable housing alongside high-end developments.
2. Chennai – Coastal Development and Flood Resilience
   - Vision: Use artificial islands to serve as flood buffers and create new urban spaces.
   - Goals: Build flood-resistant housing and infrastructure that can handle cyclones and rising sea levels.
3. Goa – Sustainable Luxury Coastal Development
   - Vision: Promote eco-friendly luxury housing and tourism infrastructure.
   - Goals: Develop high-end properties while ensuring the protection of coastal ecosystems.
4. Kochi – Smart City and Tech Innovation
   - Vision: Turn Kochi into a tech hub by building smart islands with sustainable housing.
   - Goals: Support affordable housing, integrate green energy, and create tech-driven infrastructure.
5. Visakhapatnam – Port City and Economic Growth
   - Vision: Expand port activities and provide housing for the growing workforce.
   - Goals: Enhance logistics, industrial zones, and eco-friendly residential spaces.
6. Andaman and Nicobar Islands – Strategic and Sustainable Development
   - Vision: Create eco-friendly islands to support tourism and strengthen India's strategic presence.
   - Goals: Develop tourism, housing, and security infrastructure while protecting biodiversity.
7. Puducherry – Tourism and Urban Expansion
   - Vision: Leverage coastal appeal for luxury eco-tourism developments.

- Goals: Boost tourism with sustainable resorts and housing projects.

8. Smart City Projects
   - Vision: Incorporate artificial islands into India's Smart City Mission for sustainable urban development.
   - Goals: Create tech-enabled, climate-resilient spaces to tackle housing shortages.
9. Key Development Themes:
   - Sustainability: Prioritise environmental protection, renewable energy, and eco-friendly infrastructure.
   - Affordable Housing: Ensure a mix of affordable and luxury housing options.
   - Climate Resilience: Build infrastructure that can withstand natural disasters.
   - Smart Infrastructure: Incorporate technology for efficient resource management and better quality of life.

**Case Study: Willingdon Island, Kochi, India**

Overview:
Willingdon Island is a man-made island located in Kochi (Cochin), Kerala, India. Named after Lord Willingdon, the then Viceroy of India, the island was constructed in the early 20th century to serve as a key port and trade hub. It plays a significant role in India's maritime trade and military activities in the Arabian Sea. Willingdon Island is one of India's earliest examples of large-scale land reclamation. (See Figure 4)

Figure 4: A scenic view of Willingdon Island, highlighting its urban and natural landscapes.
*Source: Wikipedia*

Key Features:

- Location: Situated in the backwaters of Kochi, Willingdon Island is strategically located between the mainland of Kochi and the Arabian Sea.
- Purpose: The island was built primarily to develop Kochi's harbor facilities, accommodating the growing demand for maritime trade, and to establish naval and commercial infrastructure.
- Development: It hosts the Cochin Port, the headquarters of the Southern Naval Command of the Indian Navy, and many offices of the Cochin Shipyard. It also has luxury hotels, warehouses, and residential areas.

Historical Background:

- Construction: The island was created between 1924 and 1939 using dredged material from the Vembanad Lake and the surrounding waters. This dredging was part of a larger project to modernise and expand Kochi's port under the leadership of Sir Robert Bristow, a British harbour engineer.
- Key Milestone: The island was officially completed in 1939 and became a critical hub for British naval operations during World War II. It later became a commercial and military centre post-independence.

Economic Impact:

- Port Development: Willingdon Island houses the Cochin Port, one of India's largest and most important ports. It handles a significant portion of India's cargo traffic, particularly in exports of spices, tea, and coffee from the region.
- Trade and Shipping: The island's modern infrastructure has bolstered Kochi's position as a key centre for trade and shipping in India, linking it to global maritime routes.
- Tourism: With luxury hotels like the Taj Malabar, Willingdon Island also contributes to Kochi's tourism sector, serving as a gateway for tourists visiting the backwaters and other attractions in Kerala.

Environmental Impact:

- Land Reclamation Process: The dredging of the backwaters and use of silt to create the island led to changes in the natural water flow, which affected the local marine ecosystem. However, given its historical context, environmental concerns were less of a focus during the island's construction compared to modern reclamation projects.

- Marine Life and Biodiversity: There were some disturbances to the mangrove ecosystems and marine life due to the island's construction. However, Willingdon Island has coexisted relatively well with the surrounding environment, with ongoing efforts to maintain a balance.

Socio-Economic Impact:

- Job Creation: The establishment of the Cochin Port and related maritime activities on the island has created thousands of jobs in the shipping, logistics, and tourism sectors.
- Military Presence: The Indian Navy's Southern Command headquarters on the island has boosted defence infrastructure in the region, contributing to the local economy and security.

Challenges:

- Siltation and Dredging: Over the years, the port has faced challenges related to the silting of the waterways, requiring regular dredging to maintain the depth needed for large vessels.
- Environmental Sustainability: With the increasing emphasis on environmental conservation, balancing development with ecological preservation is a challenge for the island's future growth.

Future Outlook:

- Port Expansion: There are ongoing plans to expand Cochin Port and improve infrastructure on the island to accommodate the increasing demands of international trade.
- Sustainability Efforts: Recent initiatives are being introduced to promote sustainable practices on the island, including better waste management systems and eco-friendly port operations.

**Conclusion:**

Artificial islands could help alleviate land shortages in coastal cities like Mumbai, Chennai, and Kochi. Success depends on overcoming environmental, financial, and regulatory challenges while ensuring these projects serve a broad segment of the population.

Willingdon Island is a pivotal example of early 20th-century land reclamation in India, combining strategic military, commercial, and economic importance. Its development has played a key role in transforming Kochi into a major port city. As the island continues to evolve, addressing environmental concerns and maintaining sustainable growth will be essential for its long-term success.

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**Krishna Sahani** (A17550) completed a Bachelor of Architecture in 2022 and is currently pursuing a Master's in Building Engineering and Management (MBEM) at the School of Planning and Architecture, Vijayawada. Passionate about sustainable urban development, Krishna aims to integrate innovative solutions into modern architectural and planning practices.
*Email: krishna112095@gmail.com*



**Dr. Venkata Krishna Kumar Sadhu** is an architect and housing planner with more than 25 years of professional experience in the fields of architecture and planning. Housing, real estate, and contract management are the key areas of expertise. His research interests include vernacular architecture, human settlements consolidation, land subdivision, real estate, spirituality, and contemplative practices.
*Email: krishnakumar.sv@spav.ac.in*

ARTICLE

# Let us also learn from Animal Architects!

By Prof. (Ar.) Subodh Shankar

## Introduction

Since civilisation began, humans have considered themselves the most intelligent, creative and orderly entities on earth and denounced animals as foolish and dumb creatures by default. However, various scientific studies reveal otherwise and suggest that we human beings, particularly architects and urban planners, need to learn a lot from animals, specifically in terms of sustainability and orderly construction. This paper focuses on the intelligent and immaculate construction and planning attributes of various animals, which are broadly categorised as follows:

a. terrestrial or on-ground animals

b. aerial or winged animals, and

c. aquatic or marine animals.

## Objectives and Methodology

The objective of the study is to create an awareness amongst architects and urban planners that a lot of animals exist from whom a lot can be learned and gathered, especially in terms of sustainability, site selection, work scheduling etc**.** The study is based on secondary sources and no primary surveys have been conducted by the author. The study is limited only to terrestrial and aerial animals only.

## Terrestrial Animals

Terrestrial animals are animals that live predominantly or entirely on land e.g., cats, dogs, ants, rodents, flies, wasps, bees etc. It has been observed that animals like white ants, groundhogs, spiders and honey bees construct state-of-the-art habitat structures for their protection and living. Some of such habitats are discussed here.

### a. Termite Mounds

The ugly-looking termite mounds are structures with state–of–the–art, unbelievable air conditioning modules with 'silos' for storing food and other unassuming features (figure 1). Such structures, which to a common man just look like a heap of mud, are abundantly found in Africa, South Asia, and Australia. But, these are subjects of further research and exploration for architects and bio-scientists.

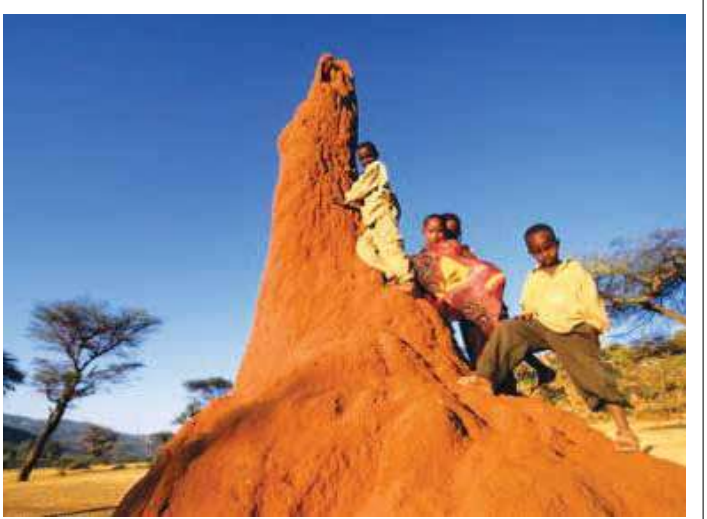

Figure 1: Commonly found termite mounds in Asia and Africa
*Source: https://nationalgeographic.grid.id/read/13285166/fakta*

The mound structures rise to a height of 10 meters. These consist of 2 parts (figure 2) – the one which is above the ground has an outer wall punctured with tiny holes and leads to a complex network of tunnels that ventilate themselves through a series of chimneys. The second part which is below the ground is a large, oval-shaped nest. Here, the termite queen resides, and food in the form of fungi is stored at a constant temperature of 35.5 degrees centigrade.

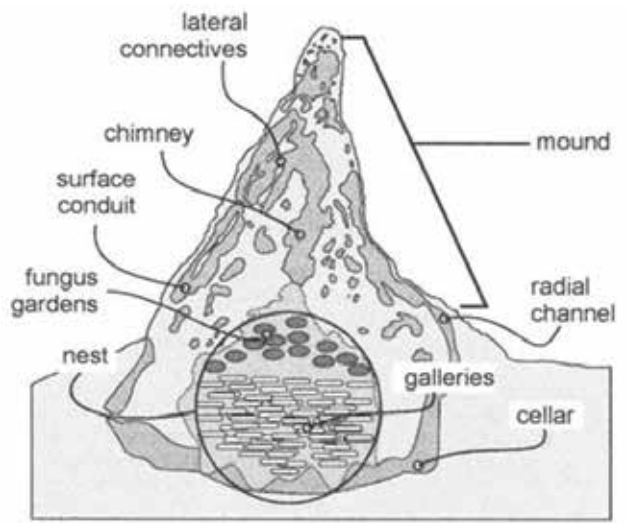


Figure 2: Profile of the termite mound
*Source: https://www.researchgate.net/figure/A-representative-cross-section-through-a-mound-of-a-Macrotermes-michaelseni-nest-showing_fig5_226717911*

The termite nest is like a city with habitable cabins and a network of lanes and bylanes. The 'city' has large-sized exclusive chambers for the queen and the king. The 'lanes' are bustling day and night, with long lines of busy 'worker' termites arranging food for all the inhabitants. They also care for the eggs that the new termites are developing. They also repair and enlarge the nest. The 'lanes' or 'streets' are ventilated by an intricate system of air-conditioning.

There exists an intricate air-conditioning system in these mounds which indeed is a matter of great research for air-conditioning experts. On this topic there are two theories in place. As per the first theory, the mound air dissipates through the network of its tiny holes and as the temperature rises during the day, the air in the thinner chimneys on the outer edges of the mound heats up quickly, while the air in the mound's big, central chimney stays relatively cool. Then, hot air rises through the outer chimneys and the central chimney's cool air sinks, thus ensuring a continuous flow of air, thereby providing vital oxygen and flushing out the dirty carbon dioxide. During night, when the temperature drops, the flow reverses, as the outer chimney air cools down quicker than the inner chimney air.

The termites achieve this remarkable feat by constantly opening and closing a series of heating and cooling vents throughout the mound over the day. With a system of carefully adjusted convection currents, the air is sucked in at the lower part of the mound, down into enclosures with muddy walls, and up through a channel to the peak of the termite mound. The industrious termites constantly dig new vents and plug up old ones to regulate the temperature.

However, according to the second theory, as promulgated by Dr. J. Scott Turner, an environmental scientist of the State University of New York College, the mounds act similar to our lungs, which inhale and exhale through their walls which are highly porous but are impenetrable. Furthermore, a series of bubble-like chambers, connected to branching passages inside the mound, absorb changes in outside pressure or the wind and pass them through the mound. With the changing conditions, the mounds are constantly remodeled automatically to regulate the mix of gases and to maintain a stable nest environment. Turner sums up his research by saying that "a termite mound is like a living thing, dynamic and constantly maintained" (Turner, 2009).

After having learned about the extraordinary air-conditioning and ventilation properties of termite mounds, architects world-over are fascinated to use the 'termite mound technology' in real-time buildings. One example of such a creation is at Harare, Zimbabwe which is illustrated below.

**Eastgate Centre in Harare, Zimbabwe**

Inspired by the 'termite mound technology', Zimbabwean architect Mick Pearce has successfully implemented this concept at the Eastgate Center in Harare, Zimbabwe. This shopping cum office complex has been designed without using the conventional HVAC system yet providing a comfortable environment within the 8-storeyed building complex. In this building, outside air is drawn in and is either warmed or cooled by the building mass depending on which is hotter - the building concrete or the air (figure 3). According to Pearce, there is a 10% saving in energy consumption as compared to a normal building of this size. It is indeed an architectural marvel in its use of biomimicry principles. This building won an award from the International Council of Shopping Centres in 1997, making it the first building in Africa to receive this award.

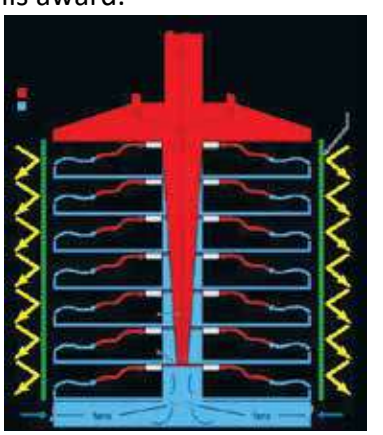

Figure 3: A schematic diagram showing the natural ventilation of Eastgate Centre
*Source: https://www.brunel.ac.uk/IamBrunel/Post?entryid=19a5411a-1d1e-415e-a43d-ae818a4bad5e*

**b. Groundhogs or Woodchucks**

Groundhogs or woodchucks, which are a type of rodent, are extensively found in certain parts of Central and Eastern United States, and also in Alaska and Canada. They mostly live underground in complex burrow systems by digging the well-drained dry soil (figure 4). The woodchuck burrow is just not an ordinary hole in the ground; it is a complex system of entrances, tunnels, and chamber-like rooms. These burrows are like a normal human residences having an exclusive bed space as well as a toilet chamber. Besides, there is a spy hole for keeping a watch on the predators and this acts as an escape route too. During hibernation, the entrance is plugged with sand. The burrows maintain a comfortable environment i.e. are warm in winter and cool in summer.

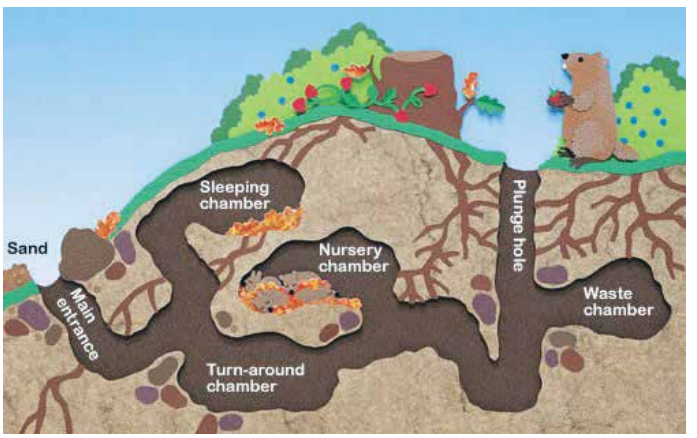


Figure 4: An artist's impression of a groundhog burrow
*Source: https://naturalwonders.substack.com/p/where-does-all-the-dirt-from-a-groundhog*

**c. Beaver Dams**

Beavers are known for building excellent 'dams'. They create massive dams with the help of mud, stones, wooden tweeds, etc., and thereby, form 'still ponds' that also irrigate woodland areas. In this way the natural environment of the nearby area gets uplifted and a nice ecosystem is built in and around these dams. Beavers may be termed superb irrigation engineers.

**d. Spider Web**

We are all aware of spiders and especially their silk which creates unassuming webs wherever suitable space and environment is found. The spider silk is self-produced through some kind of saliva the spiders possess. Spider silk is as strong as some steel alloys and can withstand three times the impact force of silkworm silk. It is tougher than bulletproof Kevlar, is extremely ductile and is more waterproof than silkworm silk. The web consists of a durable silk frame made up of outer bridge lines with internal anchor lines that are pulled downward to create spokes. The geometry of a spider web is vital to its biological functions, such as capturing prey, protection and housing. Both, radial and spiral threads of a spider web, have their inbuilt characteristics, and the geometry defines how the silk fibers are connected and anchored to substrates. Based on the principles of spider webs many interesting buildings have been constructed worldwide. The Olympia Stadium in Munich, Germany (figure 5) is one good example.

Figure 5: Olympia Stadium in Munich, Germany
*Source: https://en.wikipedia.org/wiki/Olympiastadion_(Munich)#/media/File:2022-08-*

**e. Bee Honeycomb**

A bee's honeycomb is one of the wonders of the world (figure 6). It consists of layer upon layer of hexagonal cells of identical size and shape which are stacked together as precisely as if the whole exercise was drawn on graph paper or an AutoCAD drawing was prepared. And why the hexagonal shape? The reason is stability and economy. A hexagon is considered to be the most appropriate geometric form for the maximum use of a given area. A hexagonal cell requires the least amount of wax for construction while it can store the maximum amount of honey into it. Bees are extremely intelligent and also brilliant mathematicians. They perform a waggle dance which utilises speed and directionality to communicate

Figure 6: Bees honeycomb
*Source: https;//en.wikipedia.org/wiki/Beeswax*

the location of resources relative to their current position and the sun. They start the construction from 2-3 different places and weave the honeycomb simultaneously in 2-3 strings. Though they start from different places, the bees, great in number, construct identical hexagons and then weave the honeycomb by combining these and meeting in the middle. The junction points of the hexagons are assembled so deftly that there is no sign of their being combined subsequently.

**f. Mud Daubers**

Mud daubers are lonesome wasps that construct small nests of mud in or around homes, sheds, under open furniture, etc. The nest comprises a series of cylindrical cells, plastered over to form a smooth surface (figure 7). After storing the food and laying the eggs, the wasp seals the cell with mud. A series of such cells are then sealed with mud and the she-wasp leaves the structure where the hatching larva develops itself and eventually comes out by breaking open the seal of the cell. The whole structure is abandoned after each hatching episode.

Figure 7: Urn-shaped mud dauber wasp nest
*Source: https://www.pinterest.com/pin/10-best-animal-architects-and-their-constructions--197243658659415934/*

**g. Paper Wasps**

As the name suggests, Paper Wasps get this name because of the paper-like nets created by them. This 'Paper' '-like material is produced by mixing fibers sucked from dead wood and plants with their saliva. Unlike Dauber wasp nets, these nests always remain open and the wasp takes due care of the eggs and the newborns. The nests are hung upside-down through a natural string and look like an umbrella and due to this phenomenon, these nests are also called Umbrella Nests.

**Aerial or Winged Animals**

These are animals that can transport themselves in the air either by gliding or flying. In addition to many species of birds and insects, certain other types of animals like bats and flying squirrels are aerial as well. These animals also require a habitat for rest and breeding. Some aerial animals, particularly birds, construct extremely intricate and complex structures or nests, which are difficult to be built even by humans. Some of the important attributes of the habitats of aerial animals are as follows:

**a. Site Selection**

The nest-building process starts with the selection of a safe nesting site. Birds carefully choose nest sites to maximise their possibilities of a successful breeding outcome. One or both of the parents decide on the location to construct the nest. The site selection for a suitable nest is governed by a combination of the following five main factors:

i. Availability of food for both parents and offspring,

ii. risk of predation,

iii. presence and behavior of conspecifics,

iv. availability of suitable nest material, and

v. presence of suitable ambient climate for raising offspring.

**b. Orientation**

In a limited phenomenon, some of the birds orient their nests based on the wind direction. Grasshopper sparrows and eastern meadowlarks build domed nests that are orientated away from prevailing winds and the orientation of the nests shifts temporally throughout the breeding season as the direction of the prevailing winds changes. Further, orange-tufted sunbirds, horned larks, lark buntings, and mc cown's longspurs all select their nest sites that face away from the prevailing winds. Also, the nests are located away from direct sunshine during the middle part of the day, preventing the nests from overheating. On the contrary, in arid environments, sites are selected based on the coolness factor. Thus, there exists ample evidence to show that nesting animals select sites that minimise heat loss in cool environments and prevent overheating in warm environments, thereby creating an optimal microclimate in which to raise the offspring.

**c. Construction Materials**

It is well established and there is enough evidence to suggest that nest lining materials, such as feathers, serve to create suitable microclimates to raise an offspring. Almost all birds select nest construction materials that provide thermo-regulatory benefits for the parents and the offspring within the nest cup.

**d. Construction Economics**

It is not only human beings that bother about the cost of construction; birds are also aware about the concept of 'building economics' and minimise the costs of nest construction. It has been observed that some species exploit the efforts of others by stealing nesting material or completed nests from conspecifics or heterospecifics; while other species breed in old nests despite incurring costs due to ectoparasitism. Experimental studies have also demonstrated that birds like male Australian reed warblers build multiple nests within their territories – nests that are structurally capable of holding eggs and nestlings and nests that are cheap but not structurally capable of holding eggs and nestlings.

**e. Process of Inspection and Acceptance**

Similar to the manmade construction process, birds also follow the good practice of inspection and approval of the competent authority. Under this process, the nest is constructed by the male bird and is inspected by the competent authority i.e. the female bird, at an intermediate stage, and on being satisfied mainly with the safety and microclimatic considerations, it is approved or accepted by her. In case of non-acceptance, its further construction is stopped and the male bird has to restart the construction process at a different location.

**f. Meticulous Construction Schedule**

Through extensive research, it has been established that the birds follow a strict construction schedule, including the time slots for different activities. The Baya weaver bird takes 18 days to fully construct its nest. It has also been observed that the birds undertake certain types of activities during fixed periods only. For example, the construction work of the egg chamber is undertaken between 8 to 9 in the morning and 3.30 and 5.00 in the evening, while the finishing touches to the nest are given next evening between 3.30 and 5.00 PM.

**g. Climatic Considerations**

Numerous studies have been conducted by bio-scientists on the microclimate of nests. All such studies and research conclude that the nests are scientifically designed concerning ambient temperatures, daylight factor, orientation and wind direction.

After having studied certain commonalities amongst various types of aerial animals, let us now look at the nests of some specific birds and other flying animals.

**a. The Sociable Weaver**

The sociable weaver bird, a native to Southern Africa, builds huge community nests that are home to hundreds of the little flyers (figure 8). Using sticks and grass, the weavers make these permanent homes in such a scientific way that the inner chambers of the nests stay warm during the cold season and vice versa. Their 'housing projects' are as elaborate and decadent as any manmade structure, while their entire decor is made of twigs. Like human beings, one pair of birds (e.g. husband and wife) occupies each chamber. These chambers are further subdivided into several rooms with entrances below the nest. The inner rooms retain heat and are used during the night while the outside rooms are cooler than the surroundings and are used during the day. The central chambers can retain heat and are for night-time stay, while the outer ones are for daytime use. Social weaver nests are so sturdy that they can last for many years.

Figure 8: The sociable weavers' nests
*Source: http;//thesanbush-men.blogspot.com/2011*

**b. Red Ovenbird**

The red ovenbird which is the national bird of Argentina and Uruguay uses mud or dung as the main material to build earthen bowls using their own saliva (figure 9). The nests are constructed on top of high tree limbs, poles, posts, etc., where these get baked by the sun, creating a hardened shelter where the birds lay eggs. The nests face away from prevailing winds and never face the south side.

**c. Baya Weaver**

The Baya Weaver nests are considered to be the most astonishing structures built by birds (figure 10). They use plant fibres and tall plant stems to weave extremely solid nests. To begin with, the building materials are collected and then long strips from a fresh green leaf are cut. Then the leaf fibres are tied up around the twig of a tree. With its foot, it holds down one end of the strip against the twig while

Figure 9: The red ovenbird nest
*Source: https://www.pinterest.com/pin/animal-architects-and-the-beautiful-homes-they-build--412009065885839472/*

Figure 10: Baya weaver nest
*Source: https://besgroup.org/2008/06/06/baya-weavers-nest-building-and-after/*

taking the other end in its beak. To prevent the fibres from falling away, it ties them together with knots. Slowly it forms a circular shape that will become the entrance to the nest. Then the weaving process starts with the use of its beak. During the weaving process, it calculates the required tension while visualising the finished structure. Once the weaving of the entrance is over, it proceeds to weave the walls. It pushes one fibre under another and pulls it along with its beak until it accomplishes a highly meticulous and scientific weaving project. The construction process is highly methodical and time-bound. It knows perfectly well where to thin or thicken the structure, and where to form a curve. The nests are provided strength, elasticity and waterproofing through an indigenous mortar by gathering plant fibres from the environment and mixing them with its saliva.

## Conclusion

The study of animal architects indicates that many animals are blessed with the talent of building highly scientific and eco-sensitive structures that even surpass manmade buildings. These animals are extremely caring for their offspring, for whom they build structures that protect them from their enemies and adverse climatic conditions. To achieve this objective, they search for the best possible site and build their nests with thermoregulatory materials. The habitats of some animals are so well-designed to facilitate natural air-conditioning within them. The study also reveals that animals follow a strict construction schedule and are quality and cost-conscious too. Undoubtedly, the structures built by animal architects can provide immense knowledge to human beings. However, there is very little research work that is being undertaken by architects who have by and large refrained from doing such types of non-conventional activities. As of now, most of such research work falls within the exclusive domain of bio-scientists. Let some entrepreneur architects come forward to undertake research work in this field and design their buildings based on the lessons learned from the animals 'whom we do not like to consider our equal'.

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**Ar. Subodh Shankar** (F4256) graduated from IIT, Kharagpur in 1970. He is the former Chief Architect Planner, at U.P. Housing and Development Board. He has also served as the Dean of the Faculty of Architecture and Planning, Integral University, Lucknow, and Professor at the School of Architecture and Planning, Amity University, Lucknow.
*Email: subodh.arch@gmail.com*

STUDENT WORK

# Technological Integration in Sustainable Building Design

## An Examination of Innovative and Efficient Building Solutions

By Adya Padikara, Bijoy Ramachandran and Vasudev M. Nair

### 1. Introduction

Sustainable design has long emerged as a pivotal approach to addressing the pressing problem of environmental degradation. Environmental destruction is a complex system in its own right-widespread, with deeper causes that are difficult to pinpoint. While the concept of architecture being linked to creating something that is long lasting has been a common thought for decades, many architects now believe that architecture should be linked to creating temporary structures that can be dismantled and reused. One can argue that the buildings of Rome, even though they don't exhibit the modern forms of sustainability that we've seen, are sustainable. They're sustainable through intangibility, in the sense that its meaning is of significant historic importance. It has lasted hundreds of years and fits the idea of a building needing less to function and eventually giving back. Independent of personal judgement, the idea of being sensitive to the environment is inescapable. What is needed to deem a building as 'sustainable' or 'environmentally friendly' can differ, but in simplicity, it can be narrowed down to the framework of a building.

### 1.1 Hypothesis

The effective integration of technology with sustainable building practices is essential for developing innovative and efficient construction solutions. When used harmoniously, technology can enhance the functionality, resilience and scalability of sustainable structures. However, achieving meaningful progress in this area requires adequate financial investment to support the adoption of these practices on a larger scale. This article examines the sustainability of selected buildings based on specific criteria and assesses whether their cost-benefit ratio contributes to or limits development. Additionally, it explores alternative structures that achieve similar levels of sustainability at lower costs. The primary objective is to evaluate the level of funding necessary to support the seamless blending of technology with sustainable practices for scalable, high-impact building solutions.

### 2. Methodology

While the most accurate way to document the buildings being used as examples would be a quantitative analysis, for this article, the evaluations made are based on the data being shared in the public domain, in magazines, trade journals, research papers and publicity videos for the chosen buildings. While conducting this review, a specific set of criteria have been observed:

- The project construction is completed and since then the building has been inhabited.
- The project has received national or international recognition and awards.
- The project's sustainability credentials have been verified through rating systems such as LEED.
- The structure has been used as an example or is the primary source of investigation in the literature reviewed

## 3. Sustainable architecture

Sustainable architecture is architecture that seeks to minimise the negative environmental impact of buildings through improved efficiency and sensitivity in the use of materials, energy, development space and the ecosystem at large. Sustainable design might seem like a 'new age' concept, when in reality, it has been practiced for ages. Many contemporary green technologies, such as green roofs have been around for thousands of years, are being rediscovered only when packaged as new. They were constructed from readily available, but more importantly, local materials, such as stone, earth and their designs were intrinsically tied to their geographical locations and climatic conditions. Age-old tribes have practiced these principles in various forms, whether it has been to increase natural ventilation, like the 'Qatari Barjee' in the Arabian Gulf, or the biodegradable 'Furoshiki' technique from Japan, that reduces the need for single use plastic packaging.

### 3.1 Fluidity

The idea of fluidity refers to how constantly changing conditions in modern cities affect our experiences and views on beauty in architecture and urban spaces. Sustainable fluidity is an innovative response to these ever-changing contexts, focusing on how we design spaces, especially in older neighborhoods that have lost their original character and purpose.

This concept emphasises using the ongoing changes around us to enhance the design of these spaces. When revitalising or redeveloping an area, we can bring back old qualities while also highlighting new cultural needs and aesthetic values. The role of spatial experience is crucial as it connects to the feelings, emotions and sensory interactions we have with our environment. It also promotes diversity, inclusion and overall well-being, all of which are important in sustainable development today.

### 3.2 Passive and active design strategies

Achieving energy efficiency in architecture often requires a combination of passive design strategies and active technologies. Passive design strategies utilise natural elements such as building orientation shading and natural ventilation to reduce energy consumption, while active technologies employ mechanical systems to further enhance energy efficiency. The integration of passive and active design strategies can result in benefits that maximise energy efficiency and occupant comfort. Active technologies, such as high performance insulation, energy efficient lighting and renewable energy systems can then be used to further reduce energy consumption and provide supplemental energy needs. For example, passive solar design principles can be used to maximise solar heat gain in winter, reducing the need for mechanical heating. Active technologies, such as solar photovoltaic panels, can then be used to generate electricity from sunlight to power lighting, appliances and other electrical systems, further reducing energy consumption and reliance on the grid. In conclusion, the integration of passive and active design strategies is essential for achieving energy efficiency in architecture. By combining these strategies, architects and designers can create buildings that are not only environmentally sustainable but also comfortable, healthy and cost-effective for occupants.

### 3.3 Challenges with energy efficient buildings

One of the primary challenges in energy efficient architecture is the perceived higher initial costs compared to traditional building methods. Energy efficient materials, technologies and design strategies often require a higher upfront investment that can deter developers and building owners from pursuing energy efficient solutions. However, it is essential to consider the long term savings associated with energy efficient buildings. While the initial costs may be higher, energy efficient buildings typically have lower operating costs due to reduced energy consumption. Over time, the savings on utility bills can offset the initial investment, making energy efficient buildings more cost-effective in the long run. Energy efficient buildings require careful maintenance and operation to ensure optimum performance. Inadequate maintenance can lead to system failures and increased costs ranging from 10%-30%. Additionally, occupants play a crucial role in the energy efficiency of a building. Educating occupants about energy saving practises, such as turning off lights when not in use and using appliances efficiently can help reduce energy consumption and improve the overall efficiency of the building.

### 3.4 Catalytic Buildings

Catalytic buildings (high performance buildings that boost the social, economic and physical sustainability of urban areas), boost performance of their own structure and the structures around them. They provide environmental, social and economic shared value to neighbourhoods. They ease traffic pressures, improve air quality, push social mobility upward, providing opportunities for education and innovation. Each catalytic building engages with its neighbourhood uniquely.

Defining properties of catalytic buildings:

- Profitable long term investment
- Give significantly more than they take in at least three categories of energy, water waste, ecosystem, food and/or socio economic services.
- Contribute significantly to the social, economic, health, biodiversity and environmental performance of their local area and actively prevent negative impacts.
- They transform initially unwanted or undervalued local surpluses (waste streams) into valuable services or goods.
- They facilitate connectivity between people in a community
- Maximise the efficient use of resources such as real estate, materials and energy flows before relying on new ones.
- Maximise resilience and long term adaptability of the neighbourhood through reprogrammable spaces.
- They report their sustainability performance, knowledge and experience transparently, publicly.

## 4. Contemporary sustainable building examples

### 4.1 Taipei public library, Beitou, Taipei

This is a primary example of architecture that is designed to blend seamlessly with its natural surroundings (Figure 1.1 and 1.2). The sloping green roof helps retain humidity and prevent moisture loss, channelling excess water into rainwater collection troughs. This recycled water is then used to irrigate plants and flush toilets, which supports the facility's eco-friendly design and conserves water. The rooftop is equipped with photovoltaic panels capable of generating 16 kilowatts of solar energy. A monitoring system on the first-floor wall displays real-time data on the electricity generated, making the building's energy production transparent and engaging.

To reduce heat gain, the building also incorporates deep balconies and vertical wooden lattices on its windows, which block direct sunlight from heating the interior. This design choice helps lower energy usage and improves the building's overall efficiency. In contrast to typical libraries with cramped, tall shelving, this space feels open and connected to nature. Expansive glass walls offer views of the park to the south and a flowing stream to the north, allowing sunlight to pour in and fill the space with a natural warmth and inviting atmosphere.

Figure 1: Taipei Public Library, Beitou: Exterior
*Source: Department of Information and Tourism, Taipei City Government. (n.d.)*

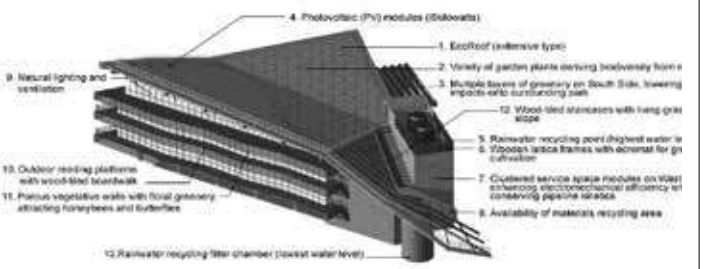

Figure 2: Taipei Public Library, Beitou: Interior
*Source: Tseng, S.-H. (n.d.)*

Because of its unique green setting, adding a parking lot would disrupt the landscape and potentially pose safety risks. Constructing an underground lot would also require several additional floors for books and reading areas, as space that could be used to house books would be used as a parking lot instead. Instead, the library encourages environmentally-friendly transportation options, like public transit, biking and walking, as it's in a pedestrian-friendly zone with only limited parking nearby.

To harmonise with Beitou's unique sulphur-rich topography, the library is built mostly from wood treated with sulphur-based preservatives to ensure durability and sustainability. The steel pillars are clad in wooden planks, creating a structure that harmonises with the surrounding natural environment, aligning with the library's commitment to green building practices.

### 4.2 The museum of tomorrow, Rio De Janeiro

The Museum of Tomorrow is designed with a strong focus on natural energy sources and light management. It cleverly uses water from the nearby bay to help control the building's interior temperature and supplies this same water for the museum's reflecting pools outside. Its photovoltaic solar panels, mounted on a unique trussed roof

(Figure 1.3 and 1.4), adjust to capture sunlight at optimal angles throughout the day, generating solar energy to power the building and reducing overall energy loss.

Figure 3: Museum of Tomorrow, Rio de Janeiro: Exterior
*Source: Prado Souza, C. M. (2021)*

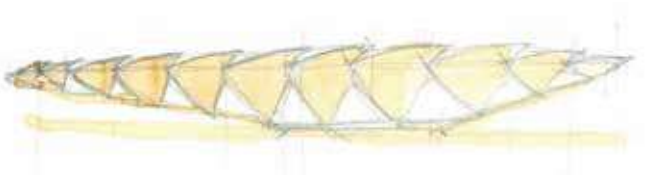

Figure 4: Museum of Tomorrow: Sketch
*Source: Museu do Amanhã. (n.d.).*

To further enhance its energy efficiency, the museum taps into the cool depths of Guanabara Bay, using deep-water cooling systems that are projected to cut energy use by around 40%. This efficient water and energy setup is predicted to save up to 9.6 million litres of water and generate 2,400 megawatt-hours of electricity within its first year alone, which is enough to supply about 585 average households. These features are expected to lower the water bill by nearly €60,000 and the electricity bill by about €260,500 annually, a direct result of its eco-friendly and energy-efficient design.

The museum's green innovation isn't only about economic savings—it also enhances the comfort of its visitors. For instance, the water mirrors around the building act as a natural cooling system, lowering indoor temperatures by about two degrees Celsius. Additionally, an advanced pumping system draws water from the bay for cooling purposes, treats it and then returns it to the bay cleaner than before, saving up to 7 million litres of water annually. The air conditioning, irrigation and cleaning systems have also been designed to minimise reliance on piped water, further boosting the museum's water efficiency.

One of the building's standout features is its smart roof, which has 48 wing-like structures attached to a steel frame. Along with 5,492 solar panels, these 'wings' adjust to follow the sun's path, generating about 10% of the museum's energy needs. To keep the interior cool, the museum employs permeable flooring with light colors that reflect heat and the surrounding landscape is planted with native vegetation that requires minimal irrigation—another step towards water conservation.

Finally, the museum actively compensates for its carbon emissions through a program called 'Reduce and Compensate CO2'. By calculating and offsetting its carbon footprint through methods like tree planting, the museum ensures that it contributes positively to the environment, aiming for net-zero emissions through practical and sustainable choices.

### 4.3 One Bryant Park, New York City, New York

New York's ageing infrastructure has some weak spots and one of its biggest issues is its sewage and stormwater system. Like many older American cities, New York was developed during a time when the primary initiative was rapid growth and industrial power, rather than managing environmental impact. This left the city with a Combined Sewer Overflow (CSO) system, which means that rainwater and sewage flow together in the same pipes. Even light rain can cause these sewers to overflow, putting a strain on the city's treatment facilities. To relieve the pressure, a mix of rainwater and untreated sewage spills straight into the Hudson River, which impacts the environment. Any effort to keep stormwater or sewage from overflowing can help reduce the environmental harm caused by CSOs.

One Bryant Park is a great example of a building working to address this issue. The building captures nearly every drop of the 48 inches of rain that falls on it each year. It has a series of collection tanks (Figure 1.5) spread throughout its floors that store over 329,000 gallons of rainwater. This water is reused to irrigate plants and flush toilets. Additionally, the building treats greywater (used water from sinks and other sources) to reuse in its cooling towers. This treated water eventually evaporates back into the atmosphere, creating a full cycle back to nature. By also using low-flow sinks and waterless urinals, the building has managed to cut its overall water use in half.

One Bryant Park also has a 4.6-megawatt natural gas-fired cogeneration plant, which powers about two-thirds of the building's electricity. This plant is efficient because it captures waste heat from generating electricity and uses it for heating and cooling, reaching up to 77% efficiency. The building maximises its energy-use by making ice at night, when demand is low, in 44 basement storage tanks.

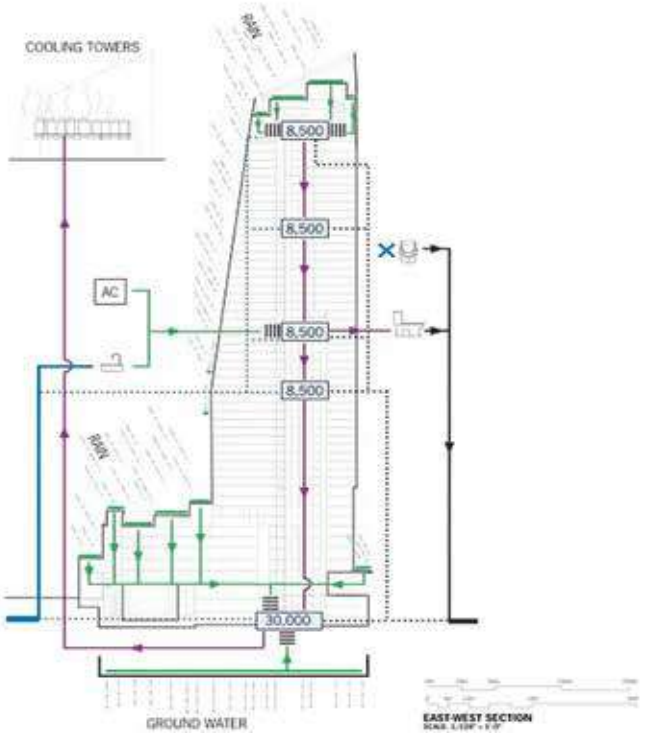


Figure 5: One Bryant Park, NYC: Water Collection System
*Source: https://uk.pinterest.com/pin/4855512068995326/*

During the day, this ice melts and helps cool the building, cutting down on energy use during peak hours.

To maintain air quality, One Bryant Park filters out 95% of particulates from the air, so the air that leaves the building is actually cleaner than what comes in. The fresh air is delivered through an underfloor air system, bringing it closer to occupants, unlike traditional ceiling systems. In a way, the building acts as an air purifier for the surrounding area, setting an example of how a catalytic building can improve quality of life for people nearby.

In terms of construction waste, the building exceeded its recycling goal, reaching 83% rather than the targeted 75%. With materials like concrete mixed with blast furnace slag and steel with 60% recycled content, One Bryant Park is made up of about 35% recycled materials overall. To save even more energy, the building uses daylight to illuminate its workspaces, using its clear glass exterior. Each floor has floor-to-ceiling windows, treated with ceramic frit—a fused enamel that reflects heat—so light can penetrate deeper without extra heat gain. This setup reduces the need for interior lighting while giving workers amazing city views.

Expectedly, saving water and energy has a financial benefit too, though it takes time to see returns. One Bryant Park's team further realised that better work conditions could boost productivity and just a small increase of 1%—or about five minutes of a workday—was estimated to bring in an extra $10 million each year. One Bryant Park is a prime example of how sustainable high-rise buildings can thrive in dense urban settings like New York City.

## 5. Analysis of sustainable building examples

While these buildings all meet and go beyond sustainability criteria adhered to worldwide, it is important to consider one of the most important factors of all: cost effectiveness. Hence the central question is - are these structures cost effective? It can be argued that they are not. The Taipei public library cost $3.8 million to construct. The Museum of tomorrow, cost $40.7 million to construct. One Bryant park cost $1 billion to construct. While these governments can afford to construct these buildings and the buildings themselves have benefits that outweigh this cost, not all countries can afford to build at this scale. Furthermore, sustainability does not have to be limited to the question of who can or cannot afford to pay for an expensive structure. As it stands, there are many sustainable ways to construct buildings that exist without the excessive spending of money.

### 5.1 Alternative sustainable practices

#### 5.1.1 Repurposing

Creating one structure that can be used interchangeably, being used as a housing structure after its use as an office building is exhausted, is sustainable in its own way, helping the housing crisis. Its sustainability comes from the fact that the building does not need to be torn down and use additional raw materials to build a new apartment complex. Arup Group, an engineering firm, released a report showing that if 220 NYC office buildings were converted to housing, they could produce 54% less carbon emissions by 2050 (these savings come from the lesser carbon footprint of renovation instead of new construction, along with maximising the efficiency of the office building's current energy use). Repurposing an office space in such a way that the extra elevator shafts could be made into garbage chutes or foyers for a line of apartments.

The double-height mechanical floor of 55 Broad, which once contained giant heating and cooling systems, would be turned into two floors of apartments. Residents would be provided with compact HVAC units under certain windows, as in a motel. These units required much less space than the old systems and were far more energy-efficient. It was noted that 55 Broad would be the first all-electric, emission-free apartment building in Manhattan. This

was not only environmentally beneficial, it also saved the cost of inserting thousands of feet of piping into concrete floors. It is an example of how monetary interest and the common good conveniently aligned.

Adaptive reuse is a form of recycling. According to a recent paper by the National Bureau of Economic Research, converting an out-of-date office building into an apartment complex can increase its energy efficiency by as much as 80% (in a residential building, not everyone uses the air-conditioning 24/7). According to a report by the Arup Group, converting a Manhattan office tower releases, on average, less than half the carbon that building one from scratch does.

As expensive as these projects may seem, the cheaper cost of repurposing an old building can allow rental prices to be set lower than they would be in a new one. It is estimated the minimum monthly rent for a studio apartment in a new Lower-Manhattan building at well over four thousand dollars, whereas a comparable apartment in 55 Broad will go for about thirty-five hundred. Although this is a considerable sum for one person, it's not especially expensive by Manhattan standards and many units might end up being shared.

### 5.1.2 Biophilia

The term 'biophilia', coined by psychologist Erich Fromm, means the natural desire to connect with other forms of life. It comes from Greek and literally translates to 'love of life'. In design, biophilia refers to incorporating nature into architecture and urban planning to boost well-being. Although this idea isn't new, it has gained more attention recently, especially after the COVID-19 pandemic, as mental health and ergonomic spaces have become more important.

A great example of this is the Boscoe Verticale, known as the Vertical Forest (Figure 1.6). This architectural design replaces traditional building materials with walls covered in various plants, using the changing colors of leaves. The idea is to create a green screen that helps regulate temperature and filters sunlight, moving away from purely mechanical solutions for environmental sustainability. The Vertical Forest contributes to a better microclimate by filtering out pollutants and producing humidity, oxygen and even noise reduction. It also addresses urban sprawl by promoting a denser city layout, where each tower can replace a whole neighborhood of single-family homes, covering about 50,000 square meters.

The selection of plants and their arrangement on the building is based on three years of research with botanists and animal behavior experts. Before planting, the plants are nurtured in a nursery to adapt to the future environment they will grow in. The residents manage the plant basins, ensuring proper upkeep and replacement as needed. Additionally, after studying the local weather, the water requirement for each area was estimated, adjusting based on sun exposure and plant placement on different floors.

Figure 6: Bosco Verticale, Milan: Green Towers
*Source: Stefano Boeri Architetti. (n.d.)*

## 7. Conclusion

Even through conservation, all ecological systems are impacted by human action. Designers today understand the urgency of reducing humanity's negative impact yet perpetuate the same mythology that relies on exploiting nature. By building hard infrastructures and favouring high-tech homogenous design, we are ignoring millenia-old knowledge on how to live with nature in symbiosis.

Even within conservation, the effect of human activity on ecosystems remains profound. While there is a growing awareness among designers about minimising negative impacts, many still lean on technological approaches that prioritise control over coexistence. Conservation practices have often sidelined resilient indigenous technologies that have effectively addressed climate challenges over millennia. True sustainability calls for adopting these indigenous methods and moving from a stance of dominance to one of partnership with nature.

The Lo-TEK movement and indigenous wisdom play a quintessential role in building climate-resilient cities. Communities like the Ma'dan of Iraq have developed sustainable, adaptive techniques for life in aquatic settings, offering insights for future designs. By embracing biodiversity, these practices show that flexible, eco-centered systems are viable, especially compared to rigid infrastructures that struggle to adapt to shifting climates.

Designers need to look beyond high-tech solutions and honour the insights within indigenous traditions. This approach requires a shift toward viewing nature as an interconnected system in which humans participate, rather than dominate. Balancing traditional wisdom with modern innovation could prevent the erosion of valuable ecological knowledge and guide us toward more sustainable outcomes. When architects shape a city, they also shape the culture and communities within it. Achieving global survival hinges on a shift from the mindset of 'survival of the fittest' to one of 'survival of the most symbiotic'.

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**Adya Padikara** is an aspiring architect with a passion for sustainable design, taking my first steps toward a career focused on eco-friendly architecture. Excited to pursue this and contribute to a greener built environment.
*Email: adya.sudhir2007@gmail.com*

**Bijoy Ramachandran** (A16443) is an architect and urban designer based in Bangalore. He is currently a partner at the internationally recognised firm 'Hundredhands'. He has a Master degree from the Massachusetts Institute of Technology, Cambridge, USA, in Architecture and Urbanism. He worked on a range of master plans and urban design projects while in Boston and New York before returning to India. He currently serves on the Board of Studies, Balwant Sheth School of Architecture, Mumbai and the Board of Reviewers, SEED, Kochi.
*Email: ramachandran-bijoy@hundredhands.com*

**Vasudev M. Nair** is an artist and educator based in Bangalore. Holding a Master's degree in Fine Arts from Shiv Nadar University and Bachelor's degree in Visual Arts from Maharaja Sayajirao University of Baroda, he has been part of various exhibitions and conducted workshops as well. In his pedagogic practice he tries to ascertain holistic learning which is also prevalent in his art practice.
*Email: vasudev.mnair@gmail.com*

DESIGN PROJECT

# Rhythmic Boundaries between the Indoors and Outdoors

by Ar. Ketki Salodkar

**Fact File:**

**Project type:** Institutional

**Project name:** Vipra School

**Location:** Hebbur, Tumakuru District, Karnataka

**Completion of project:** May 2023 (phase 1 to phase 4)

**Plot area:** 2 acres

**Built-up area:** 20,000 sq.ft (approx.)

**Principal designer:** Ar. Krishna Kumar. N

## Introduction

School is a place where most of us would have the best of memories to hold onto for lifetime. This school was evolved to accommodate the curious minds and their imagination to wonder and create memories while they run, jump, hide, roll, dance and climb. Thus, the buildings of the school were designed to enable learning in an environment that enhances collective learning and interaction at every stage in a child's development. The concept behind the design was sustainability and resource optimisation and hence the built structure attempts to create a legacy for timeless education. The purpose of each space is to create a transformative learning environment where the students get to explore and are not restricted by the time-bound education system. The building is contextual in terms of its orientation, materials used and the construction techniques adopted.

Vipra School, designed by Bangalore-based architectural firm KK&GL Partners, stands as a testament to thoughtful and sustainable architectural design. Situated on a land parcel of two acres with a built-up area of around 20,000 square feet, this educational institution demonstrates a harmonious blend of eco-friendly principles, cost-effectiveness and child-centric design. The construction was done in phases enabling incremental construction and swift operationalisation of each phase. The vision behind the school was not merely to create a space for learning, but to foster an environment that is deeply connected with nature, while also prioritising functionality, aesthetics and well-being of students and faculty alike.

## Concept and Design Philosophy

The design is underpinned by a strong commitment to sustainability and simplicity. The built structure responds artfully to the local climate and culture. The design language flawlessly articulates the vernacular sentiments and local craftsmanship tying with contemporary leanings. The use of exposed country bricks and non-plastered concrete pillars (figure 1) serves as the foundation of this eco-friendly structure. Not only do these materials reduce the

Figure 1: Scale and proportion in the corridors
*Source: KK&GL Partners*

carbon footprint of the construction but also give the school a natural and rustic charm. The aesthetic of the building is minimalistic, yet it communicates a profound respect for the environment and the local context.

The concept was also driven by the idea of being cost-effective without compromising on the quality and safety of the structure. Exposed country bricks are an affordable and durable option that helps regulate indoor temperatures, reducing the need for artificial air conditioning. Non-plastered concrete pillars provide structural stability while retaining a raw, industrial aesthetic that enhances the overall architectural appeal of the building.

**Integration with Nature**

One of the most striking features of the design is the integration of nature within the campus. The design respects the natural landscape of the site, with existing trees left undisturbed (figure 2). The design team was mindful of preserving the existing flora, acknowledging their role in providing shade, enhancing the air quality and contributing to the overall serenity of the campus. The result is a school that feels like an organic extension of its natural surroundings.

Figure 2: Main block
*Source: KK&GL Partners*

Natural ventilation is a key component of the design, making the most of the local climate to create a healthy and comfortable environment. Cross-ventilation is facilitated through *jali* (lattice work) and strategically placed windows, allowing fresh air to flow freely throughout the building. This approach not only reduces the reliance on artificial cooling systems but also contributes to energy efficiency (figure 3). The play of sunlight throughout the day, particularly in the kindergarten block, creates a vibrant and dynamic atmosphere, making the space more engaging and energetic for young learners.

Figure 3: Shade and shadow pattern created
*Source: KK&GL Partners*

**The Kindergarten Block: A Unique Architectural Feature**

The kindergarten block (figure 4) is one of the most innovative and unique elements of the Vipra School. The design of this block is both functional and symbolic, with arches that represent children holding hands — a playful and evocative gesture that reflects the unity and camaraderie of childhood (figure 5). This thoughtful design creates a warm and inviting environment, especially for the younger children, while also serving as a visual marker for the

Figure 4: Kindergarten block
*Source: KK&GL Partners*

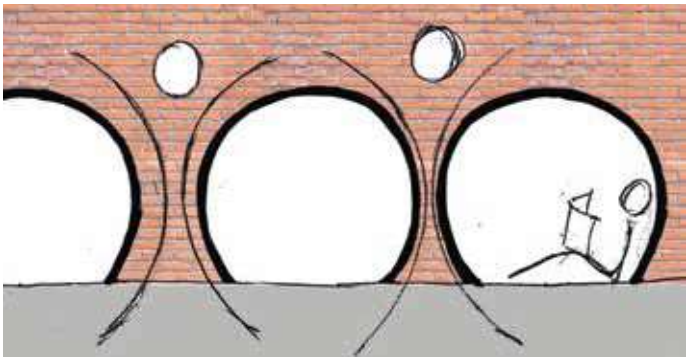


Figure 5: Concept for kindergarten block
*Source: KK&GL Partners*

entrance to the early childhood education section of the school.

Moreover, the kindergarten block is a remodeled structure, a testament to the school's commitment to sustainability and resourcefulness. Rather than demolishing the old building, the architects reimagined it, breathing new life into the dilapidated structure (figure 6) while retaining much of its original form. This approach not only preserved resources but also gave the new structure a sense of history and continuity.


Figure 6: Adaptive reuse of dilapidated structure
*Source: KK&GL Partners*

**Scale and Proportions of the Main Blocks**

In contrast to the traditional design of educational institutions, the scale of the main blocks has been carefully proportioned to suit the needs of children. The dimensions and proportions of the classrooms, corridors (figures 1 and 7) and other spaces are designed with a child's perspective in mind, making the environment more comfortable and relatable

Figure 7: Rhythmic boundaries between indoor and outdoor
*Source: KK&GL Partners*

for young students. Horizontal lines and *jali* work are incorporated to create visual interest, while also offering practical benefits like improved ventilation and a sense of openness.

The use of *jali* — an intricate pattern of openings in walls or windows — not only adds a decorative element but also serves a functional purpose. It allows for the movement of air, ensuring that classrooms

remain well-ventilated with least dependency on artificial ventilation. The interplay of light and shadow through the *jali* further enriches the sensory experience of the students as they interact with their surroundings.

**Innovative Structural Elements**

Another unique aspect of the design is the use of columns made from hume pipes, which are filled with a combination of reinforcement and concrete. This unconventional yet effective construction technique allows for significant cost savings while maintaining structural integrity. The hume pipe columns (figure 1) create a modern and distinctive look that contrasts with the traditional brickwork, adding a sense of innovation to the overall design. These columns, along with the use of concrete and other local materials, are part of a broader effort to minimise the use of expensive and resource-intensive building materials. The structural approach reflects a deep understanding of local resources and the need to build a cost-effective yet durable school.

**A Sustainable Campus**

Hebbur Vipra School exemplifies sustainable architecture in every aspect of its design. The use of eco-friendly materials, such as country bricks and locally sourced construction components, reduces the environmental impact of the building. The decision to incorporate natural ventilation, along with the preservation of existing trees, further underscores the architects' commitment to sustainability. The integration of passive design strategies ensures that the school remains energy-efficient, reducing the need for artificial lighting, cooling and heating.

The emphasis on natural light within the building plays a pivotal role in creating a positive learning environment. As sunlight moves throughout the day, it shifts across the classrooms, creating a dynamic atmosphere that encourages activity and engagement. This movement of sunlight not only benefits the psychological well-being of students but also helps in reducing the overall energy consumption of the school.

**Child-Centric Design: A Space for Learning and Growth**

At its core, Vipra School is designed to be a space that nurtures the intellectual and emotional development of children. The absence of doors (figure 8) in the classrooms (except for office spaces) promotes openness and connectivity, allowing for easy movement between spaces. The design encourages interaction and collaboration, reinforcing the idea

Figure 8: Barrier free environment
*Source: KK&GL Partners*

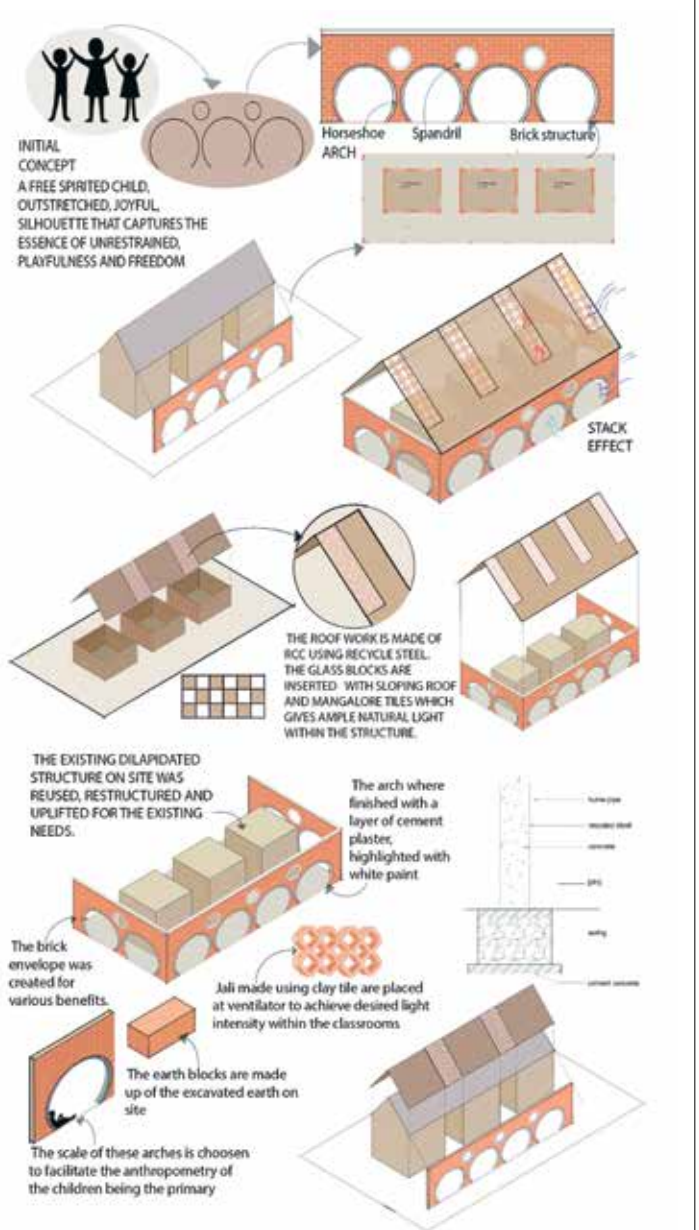



Figure 9: Conceptual development of kindergarten block
*Source: KK&GL Partners*

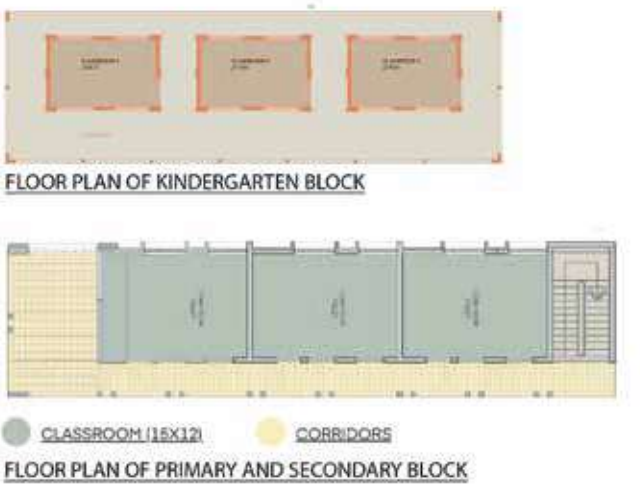



Figure 10: Floor plan of Kindergarten block and main block
*Source: KK&GL Partners*

that learning is not just confined to the classroom, but is an ongoing, fluid process that involves engagement with peers, teachers and the environment.

The use of playful, child-friendly proportions, vibrant spaces and natural elements ensures that the school is not just a place of education, but also a space that inspires curiosity, creativity and joy. The kindergarten block, in particular, with its symbolic arches and child-scaled proportions, serves as a gentle introduction to the world of learning, helping young children feel comfortable, safe and excited to explore (figure 9).

**Conclusion**

Vipra School is an exemplary model of how architecture can enhance the learning experience. Designed by KK&GL Partners, it combines sustainable building practices, eco-friendly materials and child-centric design principles to create an environment that fosters learning, creativity and connection to nature. The school stands as a reminder that thoughtful, innovative design can make a profound difference in the educational experience, ensuring that future generations have access to spaces that are not only functional but also inspiring, sustainable, and nurturing. The campus is a response to what was already there and weaves it into the fabric of school and hence breaks away from convention, giving warm and rustic architectural representation, which focuses on promoting one's all-round development.





**Ar. Ketki Salodkar** (A23235) is a graduate of the College of Architecture, Nashik, under Pune University. She has completed Masters in Urban and Rural Planning from IIT Roorkee. She has worked with WRI India and was an Assistant Professor at Dayanand Sagar College of Architecture, Bangalore. She is currently an Associate Architect at KK&GL Partners, Bangalore.
*Email: ketkisalodkar@gmail.com*

## Design Architect Bio

**Ar. Krishna Kumar** (F23316) is a partner and principal architect at Bengaluru-based firm KK&GL Partners. With a diverse portfolio that includes educational institutions, resorts, offices, banks, hospitals, temples and residences, he enjoys taking on challenging projects of every scale. His distinctive design philosophy capitalises the qualitative experience in sync with nature going beyond the physical composition.

# A Day in the Life of. . .

**By Ar. Vinyas Vardhan P G**

There is a quiet beauty in the mundane – moments of everyday life that often go unnoticed. Observing these simple, unfiltered instances offers a unique clarity and capturing them is where my passion lies.

On October 17, 2019, while walking through the streets of Shravanabelagola in Karnataka, I stumbled upon an old, abandoned building. The front doors were locked but my curiosity led me to explore further. Inside, I discovered a craftsman, immersed in his work, shaping a brass pot with quiet dedication. I stood there for half an hour, silently witnessing his process, captivated by the rhythm of his craft.

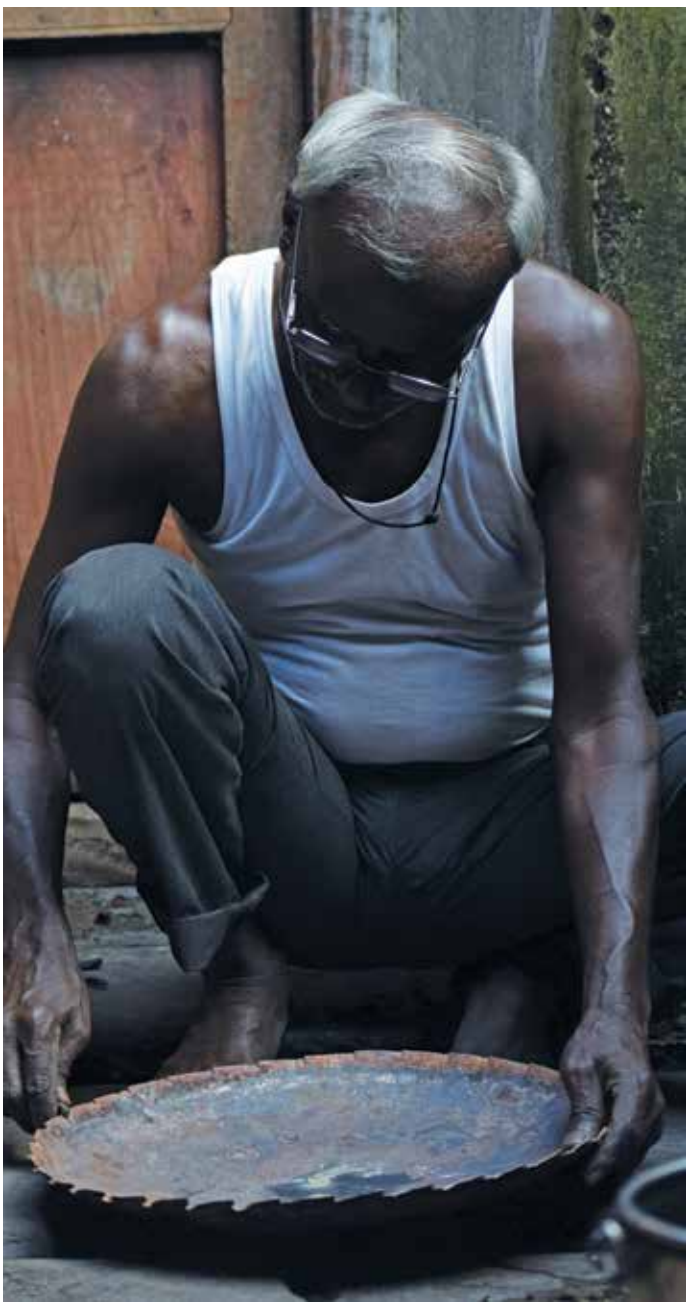
This photo essay offers a glimpse into the day in the life of a brass pot artisan, celebrating the artistry hidden in the ordinary.

This journey through the craftsman's day is a testament to the dedication behind handmade artistry – a story of patience, precision and the beauty found in the simplest of acts.

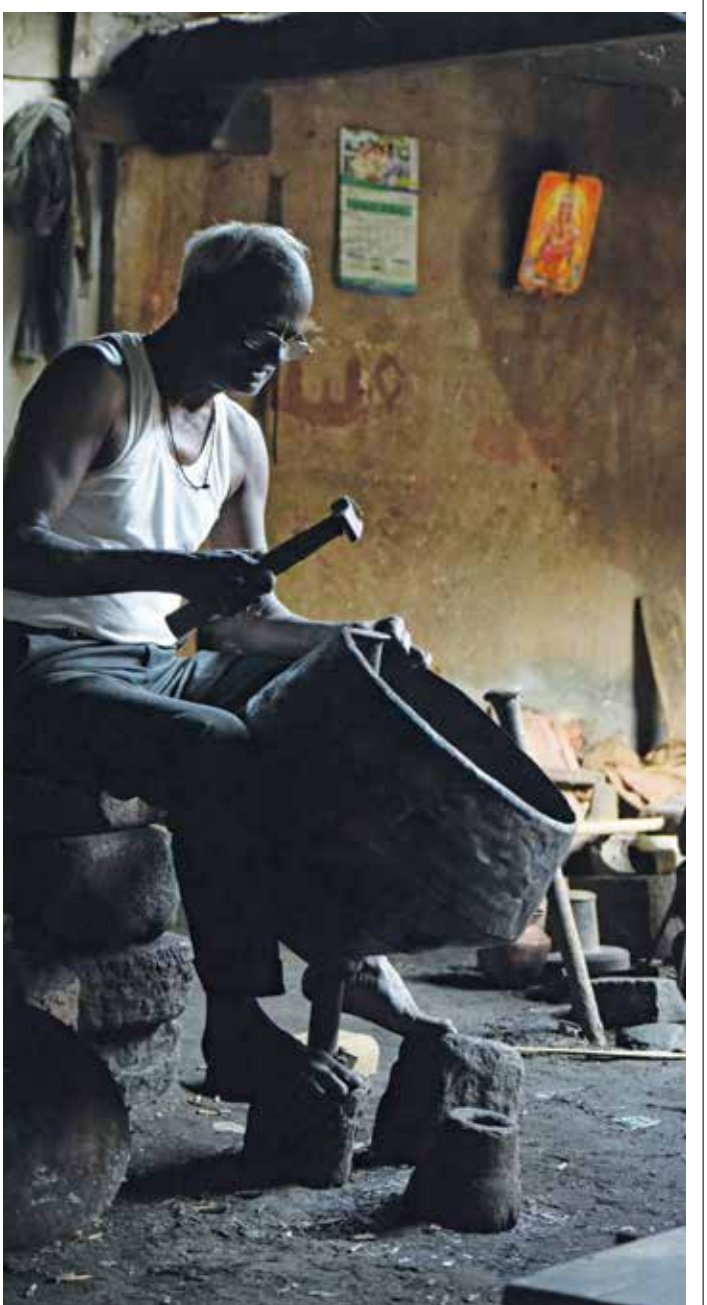
The entry scene – a doorway into a world of quiet craftsmanship

Shaping the base – the foundation of form takes shape under steady hands

Shaping the tongues – refining the details, ensuring a perfect fit



Cutting tongues – precision in every cut, a step closer to completion



Shaping the pot for the base – moulding the structure, bringing balance

And we have contact – elements align, the transformation begins

It's high time we bonded – a fusion of skill and tradition

Time to bring in the heat – fire and metal, a dance of creation

Red hot – the glow of progress, a pot nearing its final form

The exit scene – a quiet farewell to a moment frozen in time

***All Images Courtesy: Author***

**Vinyas Vardhan P G** (A29894) is an architect, educator and visual storyteller with a passion for traditional craftsmanship and everyday beauty. A graduate of BGS SAP, Bengaluru, with a master's degree from MIT SOA, Pune, Vinyas captures the essence of architecture, culture and human experience through travel and documentation. He is presently working at Amrita School of Architecture, Coimbatore, as a Faculty Associate.
*Email: vinyas11235@gmail.com*

**BOOK REVIEW**

# Sikandarah

## Calligraphy, Epigraphy, Geometry, Islimi, Poetry

**Author: Prof. Yashwant Pitkar, Ar. Richa Raut and Ar. H. Masud Taj**
**Reviewer: Dr. Smita Dalvi**

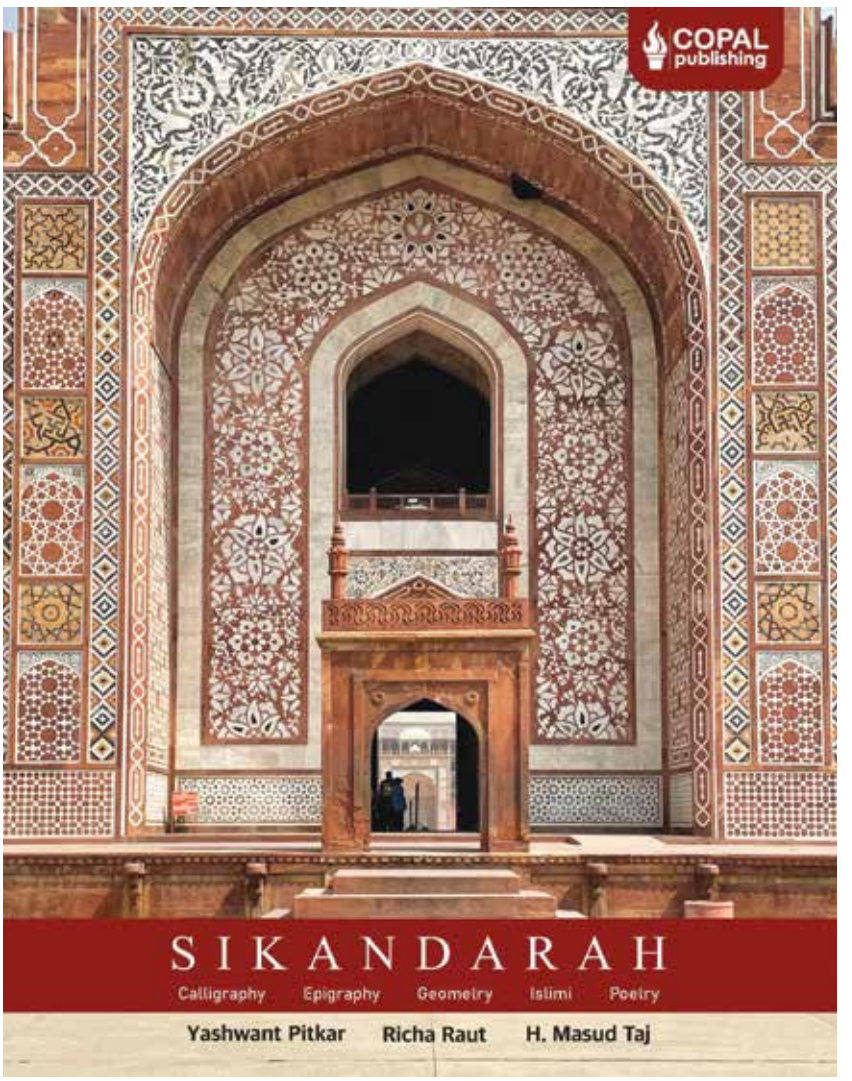



Figure 1: Book cover - Sikandarah: Calligraphy, Epigraphy, Geometry, Islimi, Poetry

ISBN: 978-91-83419-81-4
Genre: Documentation
Language: English
Publisher: COPAL Publishing Group
No of pages: 163
Year of publication: 2024

The Mughal emperor Akbar's tomb at Sikandra, located on the outskirts of Agra, is generally given a short shrift by hordes of tourists who make a beeline for the famed Taj Mahal and Agra Fort. However, an intrepid traveler venturing to the tomb complex is rewarded with spectacular monumentality and

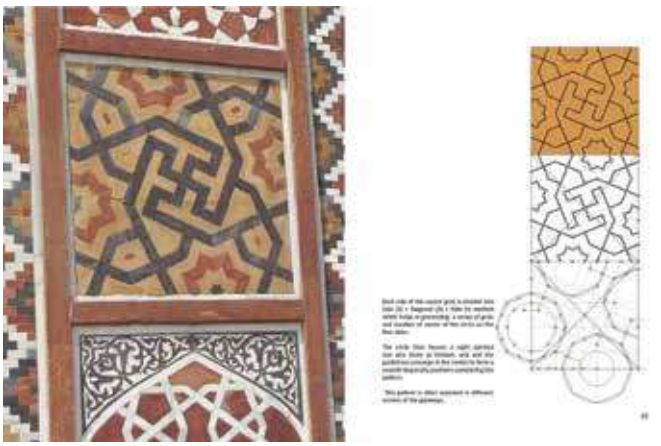


Figure 2: Geometrical analysis

Figure 3: Elevation of Tomb


Figure 4: Calligraphy

outbursts of decorations of a kind not seen anywhere else.

This mausoleum, set within a Charbagh garden, stands apart in many ways from general Mughal tomb typology. Instead of being conceived as an interior space, the structure at Sikandra is organised as layers of receding platforms, creating a stepped profile punctuated by a medley of chhatris and culminating in a terrace, where Akbar's cenotaph is located under the canopy of the open sky and not under a lofty dome. This is only fitting as a final resting place for an emperor who stood apart in his personality, beliefs and ideas of kingship.

The monument has eluded close scrutiny of scholarship or works of popular nature, until now. A group of architects have come together to bring out a book on this lesser-known Mughal monument, at least in public imagination. *Sikandarah,* the book, is as much a connoisseur's delight as is the monument itself.

This book by Copal Publishing is a bold synthesis of photography, calligraphy, epigraphy, geometry, Islimi and poetry. The curation of its contents is highly eclectic – a medley of texts, images and graphics – as each participating architect/author presents their own creative interpretation of the mausoleum.

Yashwant Pitkar's photographs plunge the viewers into the deep-end of Islamic ornament that boldly adorns the gateways and *iwan* of the tomb. His lens probes surfaces and shows what may otherwise be missed out. His camera captures the juxtapositions of severe lines forming geometric patterns and swirling curves of tendrils and florets. Islamic ornamentation with its famed jewel-like quality, reveals itself in a life of its own, transcending the function of embellishment. While the photographs bring you up-close with the materiality, textures, colour and craft, the ornamental patterns dazzle you with their complexity. The underlying logic is revealed by Richa Raut's painstakingly produced analytical graphics that explain and demystify their geometric constructions. Images and graphics, placed in tandem, present a delicate dance of coding and decoding.

Shruti Barve's deeply researched essay puts the Charbagh garden at Sikandra in context of Persian and Timurid traditions of paradise gardens. Pitkar's evocative photographs continue here, illustrating the paradisiacal imagery adorning the walls and soffits of the gateways, focusing on free-flowing vines, bouquets of flowers, vases and goblets. One can hear parrots squawk; one can see peacocks dance.

In Sikandra, a world opens out which is beyond this world. Who better to unveil it for us than H. Masud Taj, whose calligraphic and poetic forays delve into the epigraphical beauties and mysteries enshrined in this monument. His *Birds of Bihishtabad*, for instance, is a masterly translation of an inscription, laid out for the reader in full calligraphic glory in the calligrapher's own signature style. Taj also composes (and calligraphically renders) an imaginary letter by Akbar which he describes as creative nonfiction – it is in this piece that the meaning of its architecture gets encapsulated.

The way *Sikandarah* the book is conceptualised is quite unique. It shows that an architectural object is not just a formal composition of space and volumes or of bricks and stones, but is a repository of several cultural impulses. Here, a monument from the past is vested with the civilisational ethos of its time and the ideas and beliefs that animated the lifework of the man honoured in it. The multifaceted gaze of several creative individuals at Akbar's tomb, built half a millennium ago at Sikandra, offers us newer and more interesting ways of seeing and is quite remarkable in the manner in which it does.

***All images courtesy: Authors***

**Authors**



**Yashwant D. Pitkar (F5440)** is an architect, photography enthusiast and an avid collector of inks and ink pens. He has held 13 one man exhibitions of architectural photographs at various centers across the country. He is also the author of 'The Romance of Red Stone' in 2011. After teaching in Sir J.J College of Architecture for 28 years and then 8 years in Academy of Architecture, he is a visiting lecturer in many colleges.
*Email: pitkaryd@gmail.com*

**Richa Raut (A27775)** graduated from Academy of Architecture, Mumbai and completed her Master's degree in Architecture (by Research and partly by papers) from J.J School of Architecture. She is an assistant professor in Academy of Architecture, Mumbai and is a part of Grassroots Research and Consultancy on project basis. Traveller, an avid reader, postcard collector and aspiring geometer. She has been working on several publications and has published several articles on ecology and Islamic geometric designs.
*Email: richaraut@aoamumbai.in*

**H. Mausd Taj** has given worldwide talks about his expertise in architecture, poetry and calligraphy. His books include the Embassy of Liminal Spaces (2014), Alphabestiary (2011) and Nari Gandhi (2009). He was recently affiliated with Carleton University's School of Architecture and Carleton Center for the Study of Islam.
*Email: blackcube@taj.ca*

**Reviewer**

**Dr. Smita Dalvi (A10112)** is a Professor at MES Pillai College of Architecture, Panvel and the editor of Tekton – a scholarly journal of architecture. She is the current chairperson of Board of Studies in Architecture at Mumbai University. Her area of special interest is Indo-Islamic Art and Aesthetics. She has delivered several short courses and guest lectures on these subjects in India and abroad.
*Email: smita.dalvi@gmail.com*

# YOUNG ARCHITECTS' FESTIVAL 2025

## Golden Jubilee Celebrations at Mamallapuram

**Hosted by IIA Tamil Nadu Chapter, 7 to 9 February 2025**

**Ar. T. R. Palaniappan**

The Young Architects Festival (YAF) 2025 was truly a landmark event, seamlessly blending intellectual discourse, cultural heritage and architectural innovation. Hosted by The IIA Tamil Nadu Chapter during its Golden Jubilee Year, kicked off on 7 February 2025. The Festival celebrated its theme, *SYNERGY : Towards New Paradigms in Architecture* and its sub-themes, *Transcend, Transform and Together,* fostering collaboration and fresh perspectives among young architects and students.

The Festival commenced with a vibrant fusion dance performance, visually interpreting the theme and sub-themes with the architectural backdrop of Mamallapuram. The inauguration brought together IIA Office Bearers, Keynote Speakers, and the Organizing Team, marking the beginning of a dynamic three-day event.

A comprehensive souvenir was released, encapsulating the festival's vision and key moments.

The opening Keynote by Ar. Joao Alburquerque (*Bjarke Ingels Group*, *BIG*, Barcelona) on *Hedonistic Sustainability* showcased architectural projects that integrate sustainability with human pleasure and comfort.

The thematic presentations in the main hall explored were as follows:

- Reinventing the Mainstream (Ar. Murali Murugan, Ar. Malli Saravanan, Ar. Raghuveer Ramesh)
- Social Stewardship (Ar. Nimal Raghavan, Ar. Anand Sonecha, Ar. Nishitha Parmar)
- (Re) Making Context (Ar. Siddharth Sankar, Ar. Madhushitha, Ar. Avinash Ankalge)
- Practice as Enquiry (Ar. Mona Doctor-Pingel, Ar. Ujjayant Bhattacharyya, Ar. Naomy Parikh)

The parallel presentations in a smaller hall also were held on various topics:

- New Avenues for Architecture (Ar. Sriram Adithya, Ar. Vignesh Sekar, Ar. Sujatha Hingorani, Ar. Varuna Shashidhar)
- Symbiosis: Cross-Disciplinary Alliances (Ar. Aditi Agrawal, Ar. Smriti Devakumar, Ar. Apurva Bose Dutta, Ar. Bharat Ramamrutham).

The highlight of Day 2 was the Keynote Lecture by Ar. Martha Tsigkari (*Foster + Partners*, London) on *Digitalisation in Architecture and the Augmentation of Creativity*, demonstrating the power of technology in shaping the future of design.

The competitions, exhibitions and cultural experiences of YAF 25 had many participants:

- Design competitions, *Shilp* and *Enablers* engaged young architects in design explorations rooted in Mamallapuram's context, with ₹ 3 lakhs in cash prizes distributed to winners.
- A vibrant Expo featuring fifty leading brands introduced the latest architectural materials and technologies.
- A special gallery celebrated the legacy of IIA Tamil Nadu Chapter and exhibited award-winning projects by young architects. The five centers of the Host Chapter curated displays reflecting their journey so far in the past decades.

A panel titled *Yuva Unplugged*, an interactive session between IIA officials and young architects, addressed contemporary challenges in architectural practice and future pathways was very well received by the young delegates.

With Mamallapuram as the venue, it was inevitable to give the delegates a feel of the historical monuments

that the city is famous for. A guided heritage trail, led by Ar. Ramanan, provided a deep dive into architectural history.

A half-day sketching trail, conducted by Ar. Sanjeev Joshi, encouraged participants to document heritage through sketches.

Cultural performances, beach volleyball, and kite-flying infused the festival with energy and joy.

The gala evening celebrations created a vibrant and festive atmosphere, enhancing networking and camaraderie with professional DJs engrossing the delegates to be enthralled in music and light show.

The traditional hospitality of Tamil Nadu at the event was experienced by the delegates with hygienic and diverse food arrangements, showcasing regional delicacies, ensuring a delightful culinary experience.

Recognitions and awards were given to the Organizing Committee members, partners, the Guest IIA Chapter with the most delegate registrations, Centres, firms, Institutes and service providers, as well as to the winners and runner-ups of various on-the-spot events.

All the activities of the three-day Festival were documented meticulously to preserve and display for future generations.

With its perfect synergy of knowledge, creativity, heritage and celebration, YAF 2025 set a new standard for architectural festivals in India. It will be remembered as an event that inspired, educated and united young architects, leaving a lasting impact on the profession.

**Ar. T. R. Palaniappan**
Convenor, YAF 2025
Vice-Chairperson, IIA Tamilnadu Chapter

# YOUNG ARCHITECTS' FESTIVAL 2025

## Mamallapuram, IIA Tamil Nadu Chapter, 7 to 9 February 2025

Inauguration of YAF 2025: Lighting of the lamp by Ar. Vilas Avachat, President IIA

Inaugural dance performance by professional dancers


Release of YAF 2025 Souvenir - SYNERGY

Delegates at YAF 2025

Keynote Speaker, Ar.Joao Albuquerque (BIG – Bjarke Ingels Group)


Keynote Speaker, Ar.Martha Tsigkari (Foster+Partners)

Sketching Workshop

Heritage Walk

Gala Evening

DJ Night and Live Band performances

Office Bearers of IIA along with the Organising Committee of YAF 2025, IIA Tamil Nadu Chapter


Organising Committee of YAF 2025, IIA Tamil Nadu Chapter

Audience of delegates at the Parallel Technical Sessions

Traditional cuisine of Tamil Nadu

Speakers @ YAF 2025


Speakers @ YAF 2025


Team IIA at YAF 2025, Mamallapuram


Team IIA at YAF 2025, Mamallapuram

Inauguration of YAF Expo 2025 by Ar. C.N. Raghavendran

Golden Jubilee Gallery of IIA Tamil Nadu Chapter

Performance by students of architecture

# SAANJH
# IIA Northern Region Conference 2025

Saanjh, The IIA Northern Region Conference 2025, a landmark event organized by the IIA Punjab Chapter, on 31 January and 1 February 2025 successfully brought together architects from across the Northern Region of India. This Conference served as a platform for collaboration, knowledge-sharing and strengthening regional ties between the eight Chapters of the Indian Institute of Architects IIA.

**Inaugural session and Chief Guest Address**
The Chief Guest, Ar. Vilas Vasant, President IIA, inaugurated the exhibition and shared invaluable insights during the inaugural session, setting the tone for the proceedings. The event was graced by esteemed National Office Bearers of IIA, Chapter Chairpersons and National Council Members. The National Office Bearer meeting was also held during the event. Among the distinguished speakers, Ar. Jatinder Mehta, Vice President, updated the audience about UIA, while JVP Ar. Tushar provided significant updates on ARCASIA, a panel discussion emphasizing on Vision 2047 of architecture moderated by Ar. Pritpal Singh Ahluwalia, Chairman IIA Punjab Chapter, in which, along with the IIA Vice President and JVP and Vice President COA Ar. Gajanand Ram shared his perspective on the working of the Council of Architecture and IIA, shedding light on its ongoing initiatives and future objectives. Ar. Jit Kumar Gupta, Trustee of IIA shared his own views about the future. Ar. Surinder Bagha was also part of panel.

**Participation from Eight IIA Chapters of North India**
Delegations from all Northern Chapters participated in the Conference, including representatives from Punjab, Jammu & Kashmir, Chandigarh, Haryana, Himachal Pradesh, Uttarakhand, Uttar Pradesh and


Illuminating the beginning – Delegates light the ceremonial lamp at the NRC inaugural event, marking an auspicious start.


A warm welcome – the National IIA Team and Chapter Chairpersons on stage as IIA Punjab Chapter Chairman, Ar. Pritpal Singh, delivers the Welcome Address.

the Northern Chapter. The event was a true testament to the unity and commitment of the architectural community in the region. Ar. Rajan Tangar was the Convenor and Ar. Dinesh Bagat was Co-Convenor of the NRC 2025. Ar. Balbir Kumar Bagga, Chairman, IIA Ludhiana and Ar. Sanjay Kumar, Head, Event and Finance, IIA Punjab played a pivotal role in organizing the event.

**Fashion Show – Blending Architecture with Emotion**
A key highlight of the conference was a unique fashion show, where students from various architecture

institutions across the Regional IIA Chapters creatively blended architecture with emotions. This innovative representation was highly appreciated and added an artistic dimension to the event.

**Keynote Address and Technical Sessions**

One of the most anticipated moments of the Conference was the Keynote Address by Ar. Biju Kuriakose from Chennai. His insights and expertise provided invaluable learning opportunities for all attendees. Ar. Mayank Barjatya from Pune delivered a lecture on *Building Biology*, while Ar. Ashish Sompura captivated the audience with a discussion on *Aura Science* and the making of the Ram Temple. Notably, Ar. Ashish Sompura became an IIA member on the same day, further strengthening his association with the Institute. Ar. Yogesh shared his views on *Spirituality*, and Ar. Dr. Ashok Kumar from Roorkee presented on *Sustainability*.

**Inter-Chapter Quiz Competition**

An engaging Inter-Chapter Quiz Competition was another highlight moderated by Ar. Sarb Marwaha, Ar. Rashmi and Ar. Varunesh Kumra, testing participants' knowledge of IIA and CoA. The Competition was keenly contested, with the IIA Haryana Chapter emerging victorious, followed by IIA Himachal Pradesh Chapter in second place and the Northern Chapter securing third place.

**Recognition and Awards Ceremony**

The Awards Ceremony was a significant part of the event, recognizing and honouring distinguished architects based on nominations from their respective Chapter Chairpersons. This initiative celebrated excellence in architecture and encouraged continued contributions to the profession. Ar. Indu Arora coordinated with various Chapters for these recognitions and awards.

**Launch of NorthPoint Publication**

Another noteworthy event was the launch of NorthPoint, a periodic publication presented by the Office Bearers on stage. Ar. Harveen Bhadhari is Chief Editor of this periodical. This publication features outstanding projects by various architects of the Northern Region and research papers by students from various Chapters and is set to be widely circulated.

**Hospitality and Event Participation**

IIA Punjab Chapter played a crucial role in ensuring seamless hospitality, arranging over 100 complimentary rooms for attending architects. The Conference witnessed an overwhelming response.

Celebrating architectural expression – The winning team of 'Architecture with Emotion' ramp-walk receives the first position award for their outstanding performance.

A literary milestone – Launch of North Point, a periodic publication, by IIA President Ar. Vilas Avachat and National Office Bearers.

Champions of knowledge – Winners of the quiz from IIA Haryana Chapter receive their winning certificate from COA Vice President, Ar. Gajaanand Ram, alongside other Chapter members.

Honouring architectural excellence – Ar. Ritesh Singla and Ar. Manmohan Khokar from Mohali awarded for their outstanding contributions to architecture.

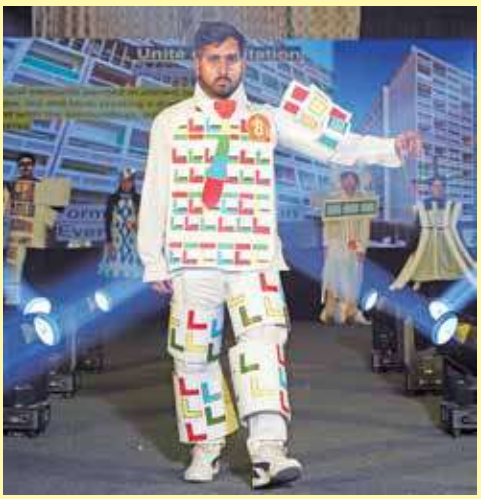
Felicitation – Ar. Sompura felicitated for his insightful presentation on the making of Shri Ram Mandir, Ayodhya.


Northern Region Award winners with the President of IIA.


Himachal Pradesh Quiz participants along with their Chairman receiving the 2nd position trophy.


Architectural elegance meets fashion.

A blend of architecture and fashion.



The harmony of design and style



Inaugural ribbon cutting by President IIA, Ar. Villas Vasant Avachat, along with Trustee IIA, Ar. Jit Kumar Gupta, and other delegates

**Passing the Baton to IIA Jammu & Kashmir Chapter**

As the Conference came to a close, the ceremonial baton for the next Annual Northern Region Conference was gracefully passed on to the IIA Jammu & Kashmir Chapter, which will host the forthcoming edition. This transition marks the continuation of this impactful regional initiative.

While every event presents its challenges, the remarkable spirit of collaboration, teamwork, and engagement displayed by all participants ensured that Saanjh 2025 was a resounding success. The Conference has laid a strong foundation for future regional cooperation and has reinforced the bond between the eight IIA Chapters of North India.

**Ar. Akaksha Sharma** (F 13023) is the correspondent of the IIA Punjab Chapter and the Head of the GNDEC School of Architecture, GNDEC College, Ludhiana.
*Email: arakankshasharma1@gmail.com*

# 12th COUNCIL MEETING OF THE TERM 2023-2025 AT MAMALLAPURAM TAMIL NADU ON 07-02-2025

| Sr. No. | Associate to Fellow | Chapter | Membership No. |
|---|---|---|---|
| 1 | Ar. Suvarna Sanjoy Ghosh | Maharashtra | F12318 |
| 2 | Ar. Ram Kumar Barwal | Haryana | F10531 |
| 3 | Ar. Vikas Bhola | Jammu & Kashmir | F13717 |
| | | | |
| **Sr. No.** | **Direct Fellow** | **Chapter** | **Membership No.** |
| 1 | Ar.Dinesh Chandra Yadav | Maharashtra | F29773 |
| 2 | Ar.Kanwal Thareja | Northern | F29774 |
| 3 | Ar.Pankaj Manikchand Tatiya | Maharashtra | F29775 |
| | | | |
| **Sr. No.** | **Associate Members** | **Chapter** | **Membership No.** |
| 1 | Ar.Ranjana Barve | Maharashtra | A29776 |
| 2 | Ar. Sayanti Syamal Pal | Maharashtra | A29777 |
| 3 | Ar. Shubhada Pratibha Agrawal | Maharashtra | A29778 |
| 4 | Ar. Reya Brahmachari | West Bengal | A29779 |
| 5 | Ar. Vishal Nandkishor Khedikar | Maharashtra | A29780 |
| 6 | Ar. Seema Naik | Karnataka | A29781 |
| 7 | Ar. Faizan Ahmed Shariff | Karnataka | A29782 |
| 8 | Ar. Anand Madhukar Dusane | Maharashtra | A29783 |
| 9 | Ar. Ankita Santosh Shraddha Jadhav | Maharashtra | A29784 |
| 10 | Ar. Kartik | Haryana | A29785 |
| 11 | Ar. Joseph Peter | Kerala | A29786 |
| 12 | Ar. Collin Jose Thomas | Kerala | A29787 |
| 13 | Ar. Josu B Sebastian | Kerala | A29788 |
| 14 | Ar. Abraham Sebastian | Kerala | A29789 |
| 15 | Ar. Namita Vijay Dharia | Maharashtra | A29790 |
| 16 | Ar. Abhishek Arvind Rewatkar | Maharashtra | A29791 |
| 17 | Ar. Shreyash Romharshan Nandanwar | Maharashtra | A29792 |
| 18 | Ar. Vaishnavi Dilip Bangde | Maharashtra | A29793 |
| 19 | Ar. Chinmay Anil Pimplapure | Maharashtra | A29794 |
| 20 | Ar. Nikhil Ashok Hindriya | Maharashtra | A29795 |
| 21 | Ar. Thangabaskar S | Tamil Nadu | A29796 |
| 22 | Ar. Abhireeka Ketan Ruikar | Maharashtra | A29797 |
| 23 | Ar. Amrut Kailas Deshmukh | Maharashtra | A29798 |
| 24 | Ar. Diksha Santoshkumar Malani | Maharashtra | A29799 |
| 25 | Ar. Kanak Deepak Chanchal Ruhatiya | Maharashtra | A29800 |
| 26 | Ar. Anupam Prasad | Jharkhand | A29801 |
| 27 | Ar. Daksh Mangla | Haryana | A29802 |
| 28 | Ar. Arjav Jatinkumar Desai | Gujarat | A29803 |
| 29 | Ar. Shrushti S | Tamil Nadu | A29804 |
| 30 | Ar. Harsh Nawaria | Rajasthan | A29805 |
| 31 | Ar. Rupesh Chamanbhai Patel | Gujarat | A29806 |
| 32 | Ar. Ketki Kulkarni | Madhya Pradesh | A29807 |
| 33 | Ar. Vassu Bansal | Punjab | A29808 |
| 34 | Ar. Ashis Pati | Odisha | A29809 |
| 35 | Ar. Ganesh K | Tamil Nadu | A29810 |
| 36 | Ar. Gajalakshmi V | Tamil Nadu | A29811 |
| 37 | Ar. Sukhpal Singh | Punjab | A29812 |
| 38 | Ar. Bhagavati R Prasad | Karnataka | A29813 |

| | | | |
|---|---|---|---|
| 39 | Ar. Jyoti P Halwai | Maharashtra | A29814 |
| 40 | Ar. S M Adish | Karnataka | A29815 |
| 41 | Ar. Sidhartha Pattanayak | Odisha | A29816 |
| 42 | Ar. Lohit P Datta | Kerala | A29817 |
| 43 | Ar. Vrushaket Govind Pawar | Maharashtra | A29818 |
| 44 | Ar. Hitenkumar Narendrabhai Kakadiya | Gujarat | A29819 |
| 45 | Ar. Sudipta Chakraborty | Odisha | A29820 |
| 46 | Ar. Hitha Valluri | Telangana | A29821 |
| 47 | Ar. A Ritika Prasad | Tamil Nadu | A29822 |
| 48 | Ar. Rajan Bhatt | Haryana | A29823 |
| 49 | Ar. Dhiyaneswaran R P | Tamil Nadu | A29824 |
| 50 | Ar. C Archana Yadav | Tamil Nadu | A29825 |
| 51 | Ar. Syed Musheer-Ul-Haq Kubravi | Jammu & Kashmir | A29826 |
| 52 | Ar. Abdulla Ameen M H | Karnataka | A29827 |
| 53 | Ar. Ashu Ranjan Mohanty | Odisha | A29828 |
| 54 | Ar. Radhika K | Tamil Nadu | A29829 |
| 55 | Ar. Raniya Muhammad Kutty | Kerala | A29830 |
| 56 | Ar. Theivanai Subramanian | Tamil Nadu | A29831 |
| 57 | Ar. Nikhar Rajesh Gandhi | Gujarat | A29832 |
| 58 | Ar. Nikhil Richard A | Tamil Nadu | A29833 |
| 59 | Ar. Yogan Divyesh Shah | Gujarat | A29834 |
| 60 | Ar. Daanish Deep Singh | Chandigarh | A29835 |
| 61 | Ar. Amal Raj C | Kerala | A29836 |
| 62 | Ar. Soorabathula Sri Harshitha | Andhra Pradesh | A29837 |
| 63 | Ar. Vignesh Karthik M P | Kerala | A29838 |
| 64 | Ar. Hemangi Gajanan Sulochana Kadu | Maharashtra | A29839 |
| 65 | Ar. Aditi Madan Sambrekar | Karnataka | A29840 |
| 66 | Ar. Ketan Tukaram Neha Goriwale | Maharashtra | A29841 |
| 67 | Ar. C S Prathyush | Kerala | A29842 |
| 68 | Ar. Keshav Gupta | Punjab | A29843 |
| 69 | Ar. Ashok Chakkaravarthy M | Tamil Nadu | A29844 |
| 70 | Ar. Yadunath R | Kerala | A29845 |
| 71 | Ar. Madhu Balla | Jammu & Kashmir | A29846 |
| 72 | Ar. Sam Exeeson | Kerala | A29847 |
| 73 | Ar. Manavi Puligal | Karnataka | A29848 |
| 74 | Ar. Ankita Toro | Karnataka | A29849 |
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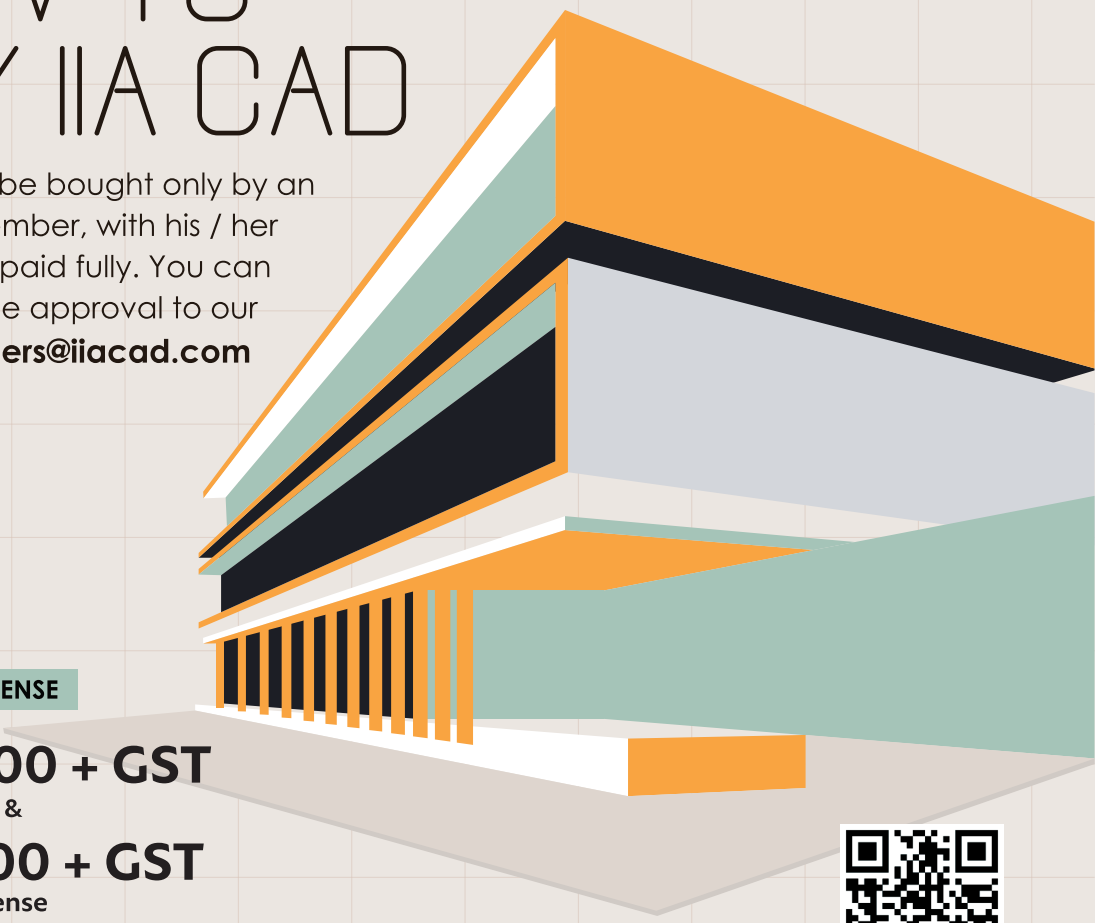

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