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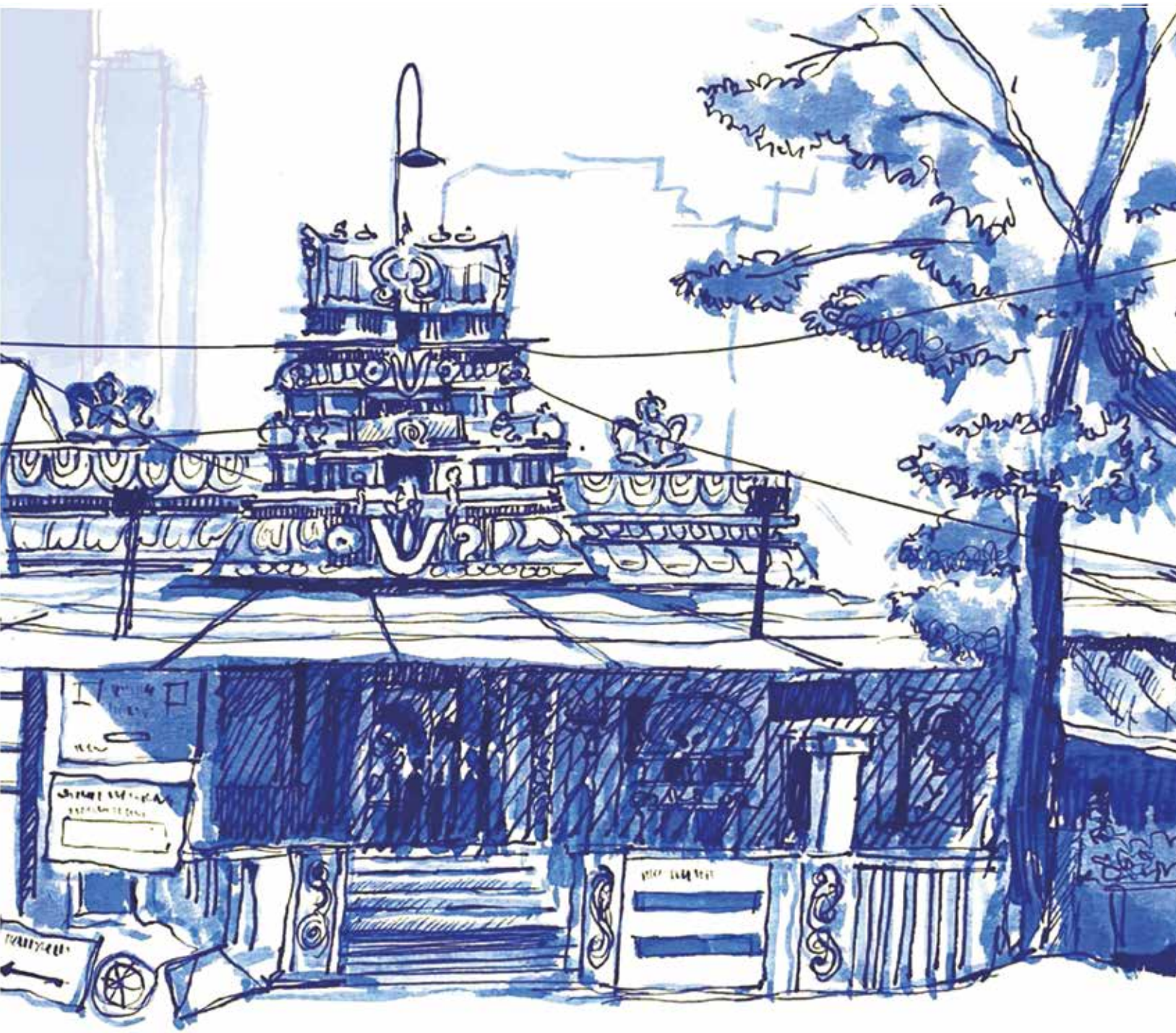

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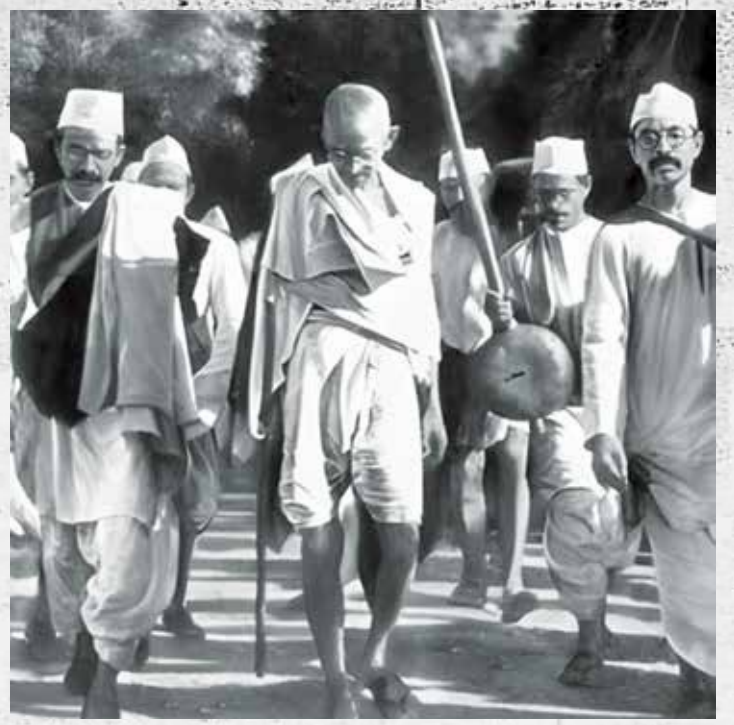

SWADESHI MOVEMENT 2.0

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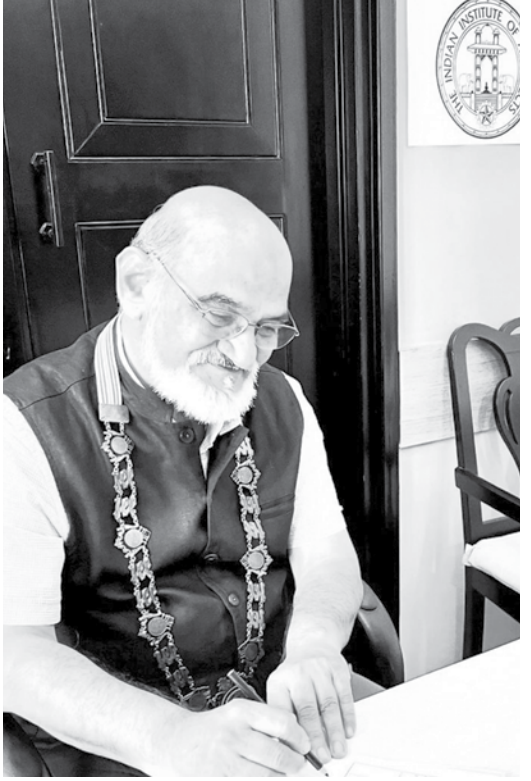
PRESIDENT'S MESSAGE



TRANSFORMATIONS 2025

Co-scripting change with disruptive technologies in architecture, design and urbanism, is an apt topic in today's scenario.

About 40 years ago when I was in the Gulf, our focus was on good drafting and good lettering- which was an asset to architects. But when were introduced to CAD, architecture was new to this digital transformation. CAD changed the way architects produced drawings and visualized and presented their ideas. But this did not change the design process. I still remember that a few years ago- in colleges, we did not allowed students to work with CAD which may not have been entirely the right decision.

Nowadays, BIM and other digital technologies have reached a tipping point and will soon transform the architecture and design industry.

Information technology (IT) and digital transformation has changed how we work and communicate. A few years ago, even the submission of municipal drawings by AUTODCR was a surprise, but now it has become common practice all over the country. It has impacted the architectural profession globally. Many architectural firms have transformed their practice with digital transformation in some way or another.

Truly disruptive digital technologies will soon transform every aspect of the architectural profession, from design process, production, visualization, communication etc.

Building technologies like Building Information Modelling (BIM), cloud computing, mobile apps, digital collaboration tools, Artificial Intelligence (AI) and 3D printing and others have not only improved our efficiency, also played an important part in innovation in architectural designs.

This technology is also transforming the construction industry. It is a certainty that this digital transformation will disrupt the architectural practice even more in the coming days and will soon change the very culture of architectural practice.

Let's wait & watch.

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EDITOR'S NOTE

Greetings to all IIA members from the JIIA team.

This has been a significant milestone in the history of the Indian Institute of Architects, where, after years of deliberations, discussions, and patient effort, the long-pending amendments to the IIA Byelaws have finally been passed with an overwhelming majority in the Special General Body Meeting held on 26 July 2025. This achievement is not just a procedural landmark but it is an endorsement of our collective will to strengthen the foundation of our Institute and to prepare it for the challenges and opportunities of the future. On behalf of the IIA National Council, heartfelt gratitude to every member who participated, debated, and voted in this process. Your engagement has ensured that our governance framework evolves in step with our profession.

In light of these changes, we would like to make a special appeal to all members, to update their memberships at the earliest. This is an important window of opportunity to regularize your membership and remain connected to the many benefits and platforms that the IIA offers.

Across our chapters and centres, various professional, academic and outreach initiatives are being organized, ensuring that the IIA remains a vibrant space for learning, dialogue and collaboration. I encourage all members to participate and contribute, so that our momentum is sustained and amplified.

We are also keenly awaiting the announcement of the IIA National Architectural Design Competition for the New IIA Headquarter at CBD Belapur, Navi Mumbai. This competition promises to be a significant architectural landmark and a symbol of our commitment to excellence in education and professional standards. This competition will be an opportunity for our fraternity to leave an indelible mark on the built environment of the Institute.

Looking ahead, preparations are already in motion for ARCASIA Forum 2026. Hosting this prestigious international event will be both an honour and a responsibility, positioning the IIA at the centre of the global architectural discourse. An event of this magnitude requires meticulous planning, creative energy, and wholehearted participation from all members to ensure that we present India's architectural voice with confidence and pride.

The road ahead is both exciting and demanding. Together, let us continue to uphold the values of our profession, seize every opportunity for growth, and shape the future of architecture in India.

We sincerely thank all our fellow IIA members whose dedication and hard work have created vibrant spaces for meaningful conversations and the sharing of ideas. It is your passion and commitment that keep Indian architecture moving forward and help our voice be heard on the global stage. We also wish to express sincere gratitude to the authors whose thoughtful contributions have been vital to this collective endeavour

We encourage all IIA members to actively engage in these initiatives and contribute to demonstrating our collective leadership on the global architectural stage.

Stay united and stay ahead.

Jai Hind.

Prof. Vinit Mirkar
Editor, JIIA

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Ink Stains of a Timeless Sanctuary

By Sandesh Jadhav

Located at Chembur, Mumbai, surrounded by urban sprawls and rapid development, standing vibrantly is a 57-year-old relic of the city's diverse cultural profile. Shri Ahobila Mutt is more than a place of religious worship; It is the mark of a community and welfare that is consistently practiced through decades.

A paradoxical tale of advertisements, posters and ornaments is evident on the edges of the temple. Weather protection and light fixtures somehow coexist with the storytelling of religious motifs, almost simulating a theatrical performance as a welcome here. These binaries are what makes up for the quintessential experience that is Mumbai. The Mutt is captured in a similar light to the rest of its context; one that has been further painted by plastics and electrical connections.

Scribbled on a Sunday morning in the middle of the monsoon, the city of Mumbai is no stranger to heavy downpours. The illustration makes use of fountain ink applied in a wash method to block out the structure and pronounced strokes to add architectural details that breathe life into it. Splotches of ink mimic the rainy weather and mood of the city. It has embraced stains and imperfections as another artistic medium. This endeavour translates the coloured reality of the Mutt into a monochromatic expression. It in a way unveiled a newer way of appreciating the presence and identity of the place.

An often overlooked trait of Mutt is their guardianship to the trees that fall within its proximity. These trees become synonymous with the temple elevation as a very timeless silhouette. Not only does the Mutt add a splash of colour but also helps visitors breathe and take a pause even before they transition into the premises. Market stalls under the tree's shaded promenades have been a practice as old as the tree's foliage. This social plugin has been constantly raising its people and the whole of its vicinity as a very direct identity of its existence.

The illustration attempts to portray this very fabric of the city. It displays layers of tone and depth to help club visual elements together. Resting as a heritage anchor, the Mutt invites you to a spiritual and temporal escapade right at the heart of the city.

Sandesh Jadhav, a recent architecture graduate, is passionate about illustration and urban sketching. With 7 years of experience in urban sketching, he crafts detailed, monochrome artworks and cartoons with bold strokes. As a Junior Architect, he applies his sketching skills to innovative landscape and urban design solutions, blending art and architecture.
Email: sandesh.architecture@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/8wDCYFusLb7hWcpa6

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

This research paper was presented at the IIA ANVESHAN Research Conference held at MCAP, Thiruvananthapuram, Kerala, 29-31 August 2024, under Stream: The Significant Present.

Course Plan as a Pedagogical Tool

To Achieve a Better Understanding of Core Town Issues in Semester VIII of B.Arch.

By Ar. Shivani S Khore and Dr. Seemantini Chaphalkar

Abstract

Architectural Design studio is the core of architectural education, where analytical and creative practices lead towards a practical approach in design education. It is a learning platform, beginning with the practical findings of the problem and culminating in a viable solution. Design studio is a process, not the final output, which begins with the pedagogical learning. In the studio, Pedagogy leads to Andragogy, and eventually to heutagogy. Architectural Course plans can be curated for practical experiences to improve analytical, cognitive, and experiential learning. The studio follows a non-linear teaching methodology where the cognitive and analytical abilities of the student develop. This paper is based on the recorded findings of the Architectural Design studio of the VIII semester, in the Vidya Pratishthan's School of Architecture, Baramati, in which the core town issues were explored and addressed as expected in the syllabus. The paper emphasises the role of the course plan in conducting the Architectural Design VIII Studio. It aims to show how the course plan acts as a pedagogical tool to achieve better conduct of the Design process. It discusses the process followed in the design studio and its relation with Pedagogy, considering the steps in Bloom's Taxonomy. It establishes the correlation between the syllabus, preparation of an effective course plan, and progress of the Design studio, resulting in multidirectional knowledge gain. Students were involved in setting the design problem based on the analytical findings of the core town survey. They designed the area program based on their learnings, which responded to the needs of the stakeholders, and the design proposal contributed to the urban realm. Tutors of the Studio observed and evaluated the students closely, at every stage, based on the course plan. Observations from each step were noted and used to improvise the course plan further if required. The paper brings out the strength of the course plan in achieving the aim of the design studio.

Keywords: Architectural Design studio, Pedagogy, cognitive, critical, Course plan, syllabus, teaching methodology.

1. Introduction

Imparting knowledge through various media and describing examples and experiences is the basic tool of teaching. Rabindranath Tagore emphasised the development of senses in his philosophy of education. Prominence was given to dance, music, art and drama in daily school life. Tagore believed in this methodology of teaching. Education is no longer instruction, but a process of inspiration and a joyous but slow absorption (Tagore, 1929; Ghosh,

2018). Constant improvisation, which explored and enhanced one's capacity, was an important aspect of his education system. This points towards the cognitive learning of students, where overall growth happens.

Architecture is an intricate field, where Design studios revolve around various aspects, including culture, context, geography, religion, etc. (Valsson, 2022). In terms of education and curriculum, modern teaching has advocated various methodologies. Pedagogy is the art of teaching. It is about educating people who can critically acknowledge the learning and are capable of addressing the issues at a broader level. Pedagogy is an amalgamation of various aspects of teaching involving both practical and theoretical. It forms a relationship between the practical aspects of learning and the technical aspects of understanding. Educators today are tasked with developing Lifelong Learners who can survive and thrive in a global knowledge economy – learners who can effectively and creatively apply skills and competencies to new situations in an ever-changing, complex world (Blaschke, 2012). Architectural teaching refers to all the tangible aspects of learning that shape individuals into professionals. This process follows various pedagogical techniques, including discussions, lectures, group activities, hands-on workshops, site visits, case studies, critical analysis, presentations, etc. The holistic approach of the students improves, considering the needs of the industry. Architectural education is driven by industry needs. Various contextual dimensions are added to the architectural education, which is an application-oriented process.

For Architectural Design, students also need to debate, interact and analyse with their faculty and Design school fellows (Maii Emam, 2019). The architectural studio commences with pedagogical tools. Here, students are exposed to various aspects of understanding the project through examples, case studies, site visits, etc. Andragogy plays its role in the next stage of the studio, where students analyse the collected data through background studies, context, parameters and observations. Design strategies, concepts and theoretical frameworks are formed in this stage. Here, Pedagogy and Andragogy govern the progress of the studio. In the next stage, the studio runs under heutagogy, following the process of evaluating, creating and applying. Here, the student develops the design program, which is discussed and allowed to be developed as a design proposal. The students work on the design by themselves, with a multidirectional knowledge transfer from peers, teachers and fellow students. It is a non-linear teaching methodology where the cognitive abilities of the student develop. Students become capable, creative and self-determined learners and acquire adaptive competency.

In architecture, the practice of teaching is perceived in various ways, in various stages of architectural education. Every decade in architecture has demanded different teaching strategies. Value systems, services, humanitarian and sustainable approaches in architecture have been the focus areas in the advancing decades (Manjrekar, 2017). If studied with pedagogical aspects, in this decade, five approaches in pedagogy can be looked at. The Direct Instruction method is tutor-oriented, and it fragments large chunks of complex concepts into a systematic manner. The Inquiry-based learning focuses on peer understanding, where students are introduced to critical analysis, exploration and problem solving. Communication and teamwork are focused on in Cooperative learning. Problem-based learning encourages students to explore real-life problems and solutions. This equips them with skills. A hands-on approach is found in experiential learning, where they learn from direct experiences and activities. The concepts of cooperative learning, flipped classrooms and vertical groups are being effectively used in architectural studio practices. This is done using smaller experiments such as group projects, cultural activities, combined classrooms, model making, etc.

The methodologies in architectural teaching have changed, based on the changes happening in recent decades. Computers had not yet been invented, and all drawings were made manually. Design learning happened concurrently while learning graphical communication. After the introduction and advancement of Computer-Aided-Design, the notion of teaching changed. With the onset of Artificial Intelligence (AI) and advanced visualisation software, the knowledge and skills embedded in digital drawings can be stored, reused, copied and duplicated. Therefore, it is a challenge to ensure genuine learning and skill development. Software like Enterprise Resource Planning, Learning Management System, and others are being used for communication, assessment, data generation and storage, reducing the repetitive tasks in teaching-learning and offering access to archives of teaching tools. This change in teaching methodologies has dealt with changing times, rather than taking a step ahead. Still, it has barely ensured the serious involvement of students in the design studios. Even students' genuine work cannot be guaranteed according to the widely available online databases. These are the challenges of the Design Studio.

This paper discusses the process and the direction in which the Architectural Design VIII Studio was conducted. It describes how Bloom's Taxonomy and other pedagogical tools directed the process of the design studio. Further, the course plan and its importance are put forth, with the intent of explaining the course plan as a tool for the Design studio. The Background and Context of the Studio is discussed for a better understanding of the process of a design problem, followed by the discussion of the experiment conducted in the Studio, pointing to the designing of the course plan, and its refinement as the studio progressed. Samples of students' work illustrate the argument of the paper.

1.1 Aim and Objectives

Aim: To discuss and emphasise the role of the Course Plan in conducting Architectural Design VIII Studio.

Objectives:

1. To understand the intent of the syllabus.
2. To understand the process of teaching concepts and methodologies.
3. To understand the process of transfer of ideas, skills and tools through studio exercises.
4. To record and document a design studio program to demonstrate the effectiveness of the course plans prepared.

1.2 Scope: Observation of Architectural Design studio, stretched over the entire semester, which also includes the process from the conceptualisation of the course plan till the course end report, at the end of the semester, is discussed.

1.3 Limitation: The study is limited to the observation of one Architectural Design Studio, of Fourth Year B. Arch, across the entire VIII semester.

2. Literature Review

A syllabus is a theoretical framework that defines the typology of design problems to be dealt with in the studio. The syllabus gives indicative parameters, broad unit outlines, and the objectives to be completed in the studio during that semester. It indicates exploration of a particular issue and probable design problems according to the level of study. According to the university syllabus, in semester VIII, in Architectural Design, students need to learn about the issues of the urban realm, considering the aspects of context, sociocultural aspects, lifestyle, setting, etc. The syllabus considers the subjects learnt so far and expects the inclusion of their understanding in the design proposal. The syllabus is revised every five years, analysing the experience of the previous syllabus. New additions are made depending on the need of time and advancement in a subject. Though the syllabus is the same for all the colleges in the university region, the approach and way of executing it may differ according to the ability of the respective studio tutors. A considerable body of literature is available discussing studio experiments.

Architectural Design needs a participatory approach in the case of studios. Collaborative techniques are needed to involve students and develop their skills (Maii Emam, 2019). The article 'Teaching architectural design through creative practices' discusses the history of architectural design education, especially M. de Chamois' memorandum to formulate a syllabus for aspects of artistic education, including architecture. Written in 1648, it was fragmented and converted into a framework for architectural education. This article also discusses the teaching methodology opted for as defined by the syllabus (Lizondo, 2019).

Architectural Design Pedagogy: Improving learning outcome, discusses the process of 'Learning by doing', where the author talks about the tutor and their ideology of teaching, which can differ accordingly. The author also emphasises that the assignments in Design studio should be holistically planned considering different contexts, cultures and experiences (Ghazian, 2013).

Architecture faculty carry a responsibility to not only instruct the student, but also to be involved in the design studio process. Students need to express their thoughts, imagination and creativity tangibly, for the studio to complete. This helps the student to develop in every aspect, including cognitive learning abilities (Vaidya, 2016). In architectural education, pedagogy and andragogy go hand in hand. The major challenge for teachers is resolving the dilemma between the aspirations of tradition and modernisation (Manjrekar, 2017). 'Bloom's Taxonomy in studio design process in architecture education' discusses various levels of Bloom's Taxonomy and the way they are planned and achieved in the process of design studio. However, the paper talks only about Architectural design studios in general and lacks a discussion of any specific semester.

Architectural studio is a learning platform, tangible, based on the practical findings of the design problem. Every architectural design process follows a method, which goes from the present aspect of the situation to the final proposal stage of designing. Here, 'STUDIO' plays a vital role. Not just a mere classroom, but an environment is created where students are

encouraged to enhance their inventiveness. The studio process is similar for all the design classes, as they are all governed by a similar thought of the basic methodology. This can vary with a few aspects depending on the intent of the design problem. The first semester to the eighth semester is a long journey, where the tenor of the studio changes. Catering minor problems to major site-based design changes the thought process of the students, but the methodology remains similar. The author discusses three main teaching and learning strategies and a practical strategy for managing design studios. These are the problem-seeking phase (only applicable to advanced design studios), analysis phase, generation and testing phase. Every phase of designing is related to the phases of pedagogy. In the reflection phase, students use communicative media. Not all the phases are unidirectional, and students will need to revisit these phases in every stage (Ashraf, 2017).

Every project introduced will have a context, site and environment, typology, end user and requirement, project brief, which will be resolved in the studio process. Starting with a series of small design problems, the complexity of the design briefs increases, as students are introduced to more design elements, aspects, thinking and theory, and thus, the amount of time they spend on the project also increases. The skill transfer process happens in the studio, where the course plan is an effective tool. The studio format also depends on the tutor's style and knowledge area. The process follows the methodology and course plan set at the start of the semester, but adjustments according to the students' progress can be made. Architectural design is a process and not the final output. Teaching and learning in the design studio in architectural education is discussed and the roles students play in promoting a sustainable environment are emphasised (Olotuah, 2016). In the studio process, various milestones such as reviews, assessments, activities and presentations are planned, ensuring a holistic development of the thinking ability of the students. Course plans govern the design studio and implement the syllabus through it. The syllabus is broken down into various modules, which come together in a course plan. Course plans can be complex according to the complexity of the project. Sometimes they are also developed considering the design abilities of the class. Architectural Course plans are curated for practical experiences, which improve experiential learning, cognitive learning, analysing, interacting, etc.

This paper specifically discusses the studio process of the VIII semester, dealing with a specific design problem related to core town issues. The focus of this study is to state how the course plan acts as an effective tool to govern the design studio. If the course plan lists specific objectives and designs specific exercises to achieve them, the students' involvement is guaranteed and effective learning is achieved.

3. Methodology

The course plan was prepared before the commencement of the studio, which underwent revisions at the initial stages. The research developed from the discussion, critical analysis and introspection to which the studio teachers subjected themselves. The changes were noted, along with timely discussions with the academic head and a critical analysis was conducted after the studio concluded at the end of the semester. Various aspects and stages of the studio, the planning and execution of various exercises, students' responses and results were noted. The process of the design studio is more important here, rather than the target.

3.1 Context and Background:

The Architectural Institute, from which this study is conducted, has been imparting quality education to students of rural and peri-urban areas since its foundation. The founding vision of the institute is to promote the academic interests of the students of rural background, in the context of the ever-increasing competition within, and globalisation of the technical education. The study was conducted in the Vidya Pratishthan's School of Architecture, Baramati, which is located around 100 km from Metro city. The course plan was prepared before the commencement of the second semester, which included all the learnings of the previous semester, of the same class. The tutor was familiar with all the aspects of the students and was able to frame the course plan according to the students' behavior. Students were divided among the tutors, which helped in the smooth running of the studio. Attention given to each student was the result of timely discussions. As the tutor, I had the responsibility of directing the studio, considering the aspect of time, limitations and understanding.

The experiment involves students of the fourth year B.Arch. in the second semester. As the students will enter the next phase of the curriculum, this critical turn, in Architecture Design VIII, forms the gist of all the learnings till semester VIII. Various design aspects are included from the previous semesters, including services, landscape, materials, technology, electives, etc. All the learnings from various subjects are put forth in this design studio needs to be focused upon.

The class of 40 students began their architectural education in 2020-21, which was a COVID Year. Hence, the classes were conducted online. The students had no exposure to physical classrooms for more than a year. Teacher–student interaction was very low, so major concepts were not clear. As the basics of designing happened online, these students were not familiar with physical model making, materials, and hands-on experience. It was somewhat difficult for them to cope with the next phases of their curriculum. So, these students were slow learners and were more detective in nature. By always remaining open to the knowledge arena, they grasped the whole process through various sources in the studio, which also included 'The way to start Designing'. Students were evaluated during the whole process, at every stage, depending on the quality of the outputs they gave.

4. Data Analysis and Findings

For architectural design, the teaching hours are eight per week, depending on the number of semesters. So, in the curriculum, they are divided twice a week, where the students get ample time for discussions and studio work. Course plans are designed considering the syllabus, time constraints, Objectives, outlines, and Pedagogical methods. Teaching methodology, core, course outline and Course Outcome are the basic pointers to be followed while designing the course plan. According to Bloom's Taxonomy final stage will be achieved once the basics are clear. The final stage of the design contains all technically correct and completed drawings, including plans, sections, elevations, details, services, etc. The other criteria include presentation drawings, which should include all the data they studied from the start of the semester. This comprises background study, comparative analysis of case studies, climatic and cultural aspects, site location and context. Basics in design studio emphasises the knowledge of ways to start designing. This includes identification of the case study and site, and preparation of the area program, bubble diagrams, on-scale zoning, zone identification, etc. Students also need to know the climate and location before starting the design.

But in Design Studio, students may need to revisit the previous stage to critically analyse the situation and then continue on the next stage. From level 1st to the last level, there will be several stages where the student may need to go to and fro, and improvise the situation, which will complement the final output. If the Course Plan is designed accordingly, then the studio can be run smoothly. Critical, Creative and Pragmatic thinking will be achieved if the course plans are specially curated for that studio, depending on the typology of the design problem, the ability of the class, the scope of experimentation, and time constraints.

The challenge of the studio was to involve the students in the process. The fragmentation of assignments into smaller exercises led to a thinking process within the students. They needed to produce drawings manually, using various forms of learning, like sketching, model making, which kept them involved in the design process. In this case, tutors were not concerned about the quality of graphics or hand drafting, we focused upon the thought process and ideas of the students, regarding the design problem. Students producing their work, in the presence of tutors, was more important in this studio.

Thus, the architectural course plan is the road map to achieve 'Design' from studios. The course plans are set by the Universities they are affiliated to. This studio focused on the core town issues of the selected area of Study.

4.1 The Experiment

In the eighth semester of B.Arch., students were at a stage where they understood design strategies, tools, factors affecting their design, and the intent of the syllabus. They had dealt with high-rise structures, construction and technology, their influence on the context, and habitable space through various subjects taught in the curriculum during the third year. Then, the sense of understanding, observation of surroundings developed, and they become more sensitive towards the setting and environment in which they thrive. The connectivity of built factors with the environment and urban realm was developed through site visits, field visits, case studies and most importantly, a study tour. This semester, the students were introduced to the complexities of the urban realm and architectural design.

Tutors noticed that students become complacent if exercise submission is after 2-3 weeks and they stop working consistently or devote time to other subjects. To keep them involved and engrossed in design every day, milestones were fragmented and divided into smaller exercises. The Course Plan (Table 1) was designed such that the complexity and depth of the understanding were achieved by a series of small exercises in every class, followed by immediate discussion and feedback. Through the process, students learned the smaller aspects of the design process; smaller exercises added up as solutions to larger assignments. Students finished

Table 1: Sample course plan (Source: Authors)

Week	Date CO Input details and mode	Title/details	Learning outcome
Stage 1			
Week -3	12/01/2024 13/01/2024 CO2, CO3 Group Discussion Of students with faculties	Understanding city Mapping through layers 1.Introduction 2.Built 3.Unbilt 4.Mobility 5.Culture & Heritage 6.Services Solutions based on the issues(primitive)	Understanding various layers of mapping. Understanding of existing site and situations and the context.
Assignment no 2 – Case study analysis -A1 Sheet • Net case study – 2 nos • Case study analysis • Comparative Case study analysis • Urban level interventions related to open spaces, Markets, Public Streets			**Study Parameters:** Location, climate, concept, innovation, Area,Context, Master plans, Sections Details, observation, conclusion,Take aways, Comparision
Week -4	**19/01/2024** **CO1** **CO2** **CO3** **1 to 1** **Group Discussion**	Pre-study -STAGE 1	Analysing the situation through visual analysis, interviews, data, mapping. **(E1)** Observation, Inferences, Conclusion, Takeaways of every group. (E2) SWOT Analysis. Problem identification through Analysis.
Assignment 3- Group wise mapping **Group 1:** Introduction Base map raster • Connectivity; • History; • Culture; • City planning evolution • Factors affecting city growth; • Schemes and agencies involved			**Group 2:** Built • Figure ground; • Building use; • Building height; • Building age • Building typology; • Ownership (Major Buildings); • Character of Façade; Public and Social Infra
Group 3: Unbuilt • Open Spaces; • Ownership; • Hierarchy of open spaces • Types; • Public/Semipublic(Use); • Natural/Manmade • Safe/Unsafe			**Group4:** Mobility • Road hierarchy, Types; • Road widths; • Types of Transportations; • Crossings, Terminals, Squares; • Parking • Area of Congestions; • Activity Nodes; • Activity Generators
Group 5: Culture, Heritage and Community • Types of heritages; • Traditions, Festivals; • Art forms • Activity spots; • Interactive spaces; • Transforming spaces • Street, Building Façade sections			**Group 6:** Services • Water; • Drainage; • Storm; • Street Lights; • Sewage; • Gas • Traditional water systems; • Traditional ways of water percolation
Week -5 **Week -6**	**27/01/24** **29/01/24** **CO2** **CO4** **1 to 1 Discussion**	Discussion on the aspects and layers studied and the documentation done till now. (Issue Identification) Discussion with students on necessary interventions and Formulating design program based on the study. Comparative analysis of Pre study and post study work. area identified for further study.	Students will be able to understand the importance of mapping and its reflection on design. Developing critical and creative thinking

Assignment 4- Issue Identification-INTERNAL VIVA • Mapping of Issues by overlapping analytical maps. • Analysis of layers of all the groups • Observation • Inferences • Conclusion • Takeaways SWOT.			**Study Parameters:** Map of issues identified Map of Inferences Map of SWOT	
WEEK 7 **STUDY TOUR**				
Week -8	**02/02/24** CO5 1 to 1 Discussion With groups. Common discussion with class	Area identified for further study Discussing the proposals within the identified urban sites. Area/Site analysis of the area identified. (Carried from conclusion of post study)	Students will be able to understand and develop critical thinking ability on various needs of the city addressing the built and unbuilt forms.	Assignment 5 A1 Sheets Exercise 3(E3)-List of proposals
Assignment no 5 – Comparative analysis of Case study and Onsite mapping • Case study should be related to issue identified • Urban level intervention Analysis to be done, with identifying proposal.			**Study Parameters:** Same as assignment 2	
Week -9	**16/02/24** **CULTURALS** **26/02/24** **CO5** **CO6** **1 to 1 Discussion With groups. Common discussion with class**	Working on Stage 3 -Identification of typology of Built space. -Analysis and Discussion on requirements. -Case Study Identification for Micro level. (2 nos) (Individual) -Preparation of Area program, based on the typology identified. address the urban issue or help to build the character and identity of the place.	Students should be able to understand, analyse and create inferences from case studies and work on framing the design area program on the topic selected. One on one discussion with students, and class discussion	Discussion of E3 with students. Assignment 6 A1 Sheets (case study) Assignment 7
Assignment 6: Analysis of typology of built space, Case Study • Proposal options (Identification) • Identification • Analysis • Requirements • Case Study			**Assignment 7:** Area Program based on Typology • Area program addressing urban issues considering the built character of space. • Minimum required areas of habitable space according to typologies. • Zoning Options, along with massing.	

the work in college itself, and submissions were completed in every studio. By engaging students in smaller exercises, they were kept involved in the process. The possibility of duplication from the archives was minimised due to this method. Students who turn up with finished drawings directly at the end of the semester also got the message and began attending studios. The course plan needed constant corrections and adjustments. Results of exercises led to interesting insights and prompted new ideas for further exercises. Innovation, students' active participation and generation of novel ideas were the result of this approach. Students could not duplicate archival work, but had to use their minds and imagination to achieve creativity each day. The process of the Design Studio became more interesting than the product.

Here, the course plan guided the aspects that needed to be covered, using a specific methodology, depending upon the factors of time, outcome and learning scope. Following the criteria of the university syllabus following aspect was worked upon, which stated that the study of an urban area, which included the aspects of mobility, movement networks, character and identity, activities, open space networks and inclusiveness, was considered. Accordingly, the area of study chosen was the Walled City, Jaipur. The Studio typology demanded an extensive pre-study of all the factors that governed Jaipur. Correspondingly, the Architectural Study tour was specially curated to spend more time in the walled city. The Course plan followed all the aspects mentioned in the syllabus. Starting with the design brief it included the intent of the studio and the method that would be followed. The course plan provided a toolkit, which helped the Studio run further, as planned. It included Aim, Objectives, and Course Outcomes, in the 1st Stage. Designing the aim and objectives of the studio helped in outlining the major focus areas of the design problem.

The conception was to run the design studio systematically, along with students. The constituents of the course plan included time, the students' ability to perform, history of performance, and syllabus. The formatting of the course plan gave direction to the thought process of conducting the studio. Time management was an important aspect of the course plan, which restricted the overuse of the time slot allocated to a certain stage. The sequence of Pre-Study- Issue Identification- Solution- Design Problem Formulation was followed, instead of revealing the Design Problem first. This helped in a better understanding of students, as they were not exposed to solutions first. So, critical thinking ability was focused upon here. After the mapping, the following pointers were given to them: Observation, Inferences, Takeaway-Conclusion. This helped in the students' cognitive development. After issues were identified, they were supposed to give options for the type of proposal for the problem identified. Group discussions with the class helped in the exchange of ideas, with a wide variety of ideas presented by them. Thus, further improvisation and brainstorming led to the designing of the Design Problem- 'Contemporising of traditional Architecture through – 'Srujan'- A platform of Culture, Art, and Creativity'. After the topic finalisation through analysis, an initial design was proposed by students, depending on the pre-study analysis and conclusion. This project emphasised the needs of the stakeholders, where the built structure was connected with the urban realm.

4.1.1 Samples of the Experiment (Exercises) (Figures 1 – 4 and Table 2)

For this particular studio, the course plan was divided stage-wise, according to the direction of the Design Studio.

Figure 1: Exercise 1-Sample mapping of Walled City, Pre-Study Tour- Types of spaces
Source: Students of Semester VIII-2023-24

Figure 2: Sample mapping of Walled City, Pre-Study Tour (Stage 1)-Built Unbuilt Layer
Source: Students of Semester VIII-2023-24

Figure 3: Exercise 2- Overlapping of layers and Problem Identification, Pre-Post Study Tour
Source: Students of Semester VIII-2023-24

Table 2: Exercise 2 - Analysis of Group (Observation, Inferences, Conclusion)
Source: Students of Semester VIII-2023-24

Sheet 1	Sheet 2	Sheet 3	Sheet 4
Observations			
• Jaipur City has influences of different periods, like Mughal and colonial, on the development of the urban fabric of the city. • The observations for Jaipur's inscription as a World Heritage City would likely mention its exceptional urban planning, architectural heritage, and cultural significance.	• The timeline shows a harmonious blend of Rajput and Mughal architectural styles, indicating mutual respect and influence. • The timeline and past of a city's cultural influences become integral to the heritage identity of a place while maintaining the city's distinctive culture.	• Event Concentration - Most of the public events in Jaipur are concentrated in January, while there are no events from March to September and limited events in November and December. • Seasonal Footfall and Economy - The concentration of events in January likely generates higher economic benefits for the local economy, while the absence of events during other months may lead to fluctuations in tourist traffic and economic activity.	• Dressing and Clothing - The timeline demonstrates the co-evolution of traditional clothing styles in Jaipur, influenced by factors such as climate, Mughal traditions, and colonial impact. It also highlights the use of local fabrics, embroidery, and materials. • Artisanal Evolution - The timeline demonstrates the transformation of dressing through history in Jaipur with a strong lens to the fusion of Mughal and European influences, showcasing the city's adaptability and resilience.
Inference			
• The inscription implies that Jaipur has successfully integrated influences from past traditions in its planning, showcasing its ability to maintain its historical character amidst modern developments. • The inscription likely indicates that Jaipur has played a significant role in the cultural and historical evolution of the region, contributing to becoming a World Heritage City.	• Jaipur's cultural continuity is evident in its architectural solutions. • Integration of traditional architectural concepts into modern urban planning.	• Traffic Impact - The clustering of events in January may lead to significant traffic congestion and inconvenience for residents, while the lack of events in other periods may result in underutilised urban infrastructure.	• Cultural Integration - The evolution of dressing and artisanal traditions in Jaipur reflects a fusion of multiple influences, like interactions from Mughal and colonial periods, representing the city's openness to change and adaptability. • Artistic Heritage - The persistence and evolution of traditional clothing styles and crafts over centuries highlight the role of artisans and design in shaping the city's cultural identity.
Conclusion			
• International Recognition: Being listed as a World Heritage City brings international recognition to Jaipur's heritage and contributes to its global significance. • Tourism and Preservation: The UNESCO designation aims to promote tourism and increase awareness about the need to preserve Jaipur's heritage buildings, traditional crafts, and public spaces.	• Importance of traditional architectural styles in modern planning. • Significance of cultural considerations in urban design.	• Economic Impact - Efforts to diversify the event calendar throughout the year could lead to a more consistent level of economic activity and improved tourist experience, and benefit the overall local economy. • Traffic Management - The city could benefit from improved traffic planning and crowd control measures during peak event periods to enhance the overall visitor experience.	• Cultural Preservation - The timeline emphasises the importance of preserving traditional clothing styles as an integral component of Jaipur's cultural legacy. • Artisanal Promotions - Efforts to promote and support artisans and crafts can boost economic development and ensure the continuation of local traditions. • Community Engagement - Supporting local artists and encouraging community participation can instill pride in the city's cultural heritage.

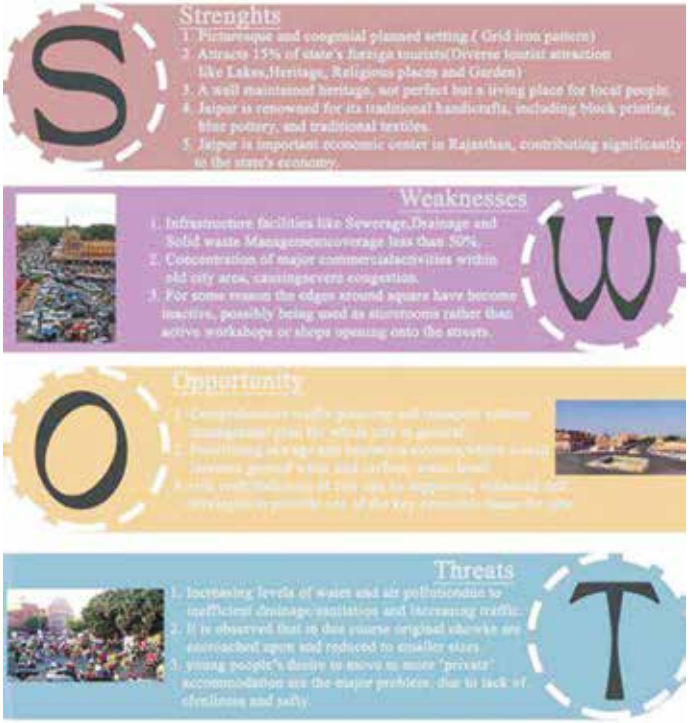

Figure 4: Exercise 3-Analysis of layers, Post Study Tour
Source: Students of Semester VIII-2023-24

4.1.2 Stage 1: Pre-Study Phase (Group)

This stage (Figure 5) included the aspects that needed to be studied before the Study Tour. Students studied the city through layers. For that, the class was divided into six groups, which were as follows:

1. Introduction
2. Built
3. Unbuilt
4. Mobility
5. Culture & Heritage
6. Services

4.1.3 Stage 2: Post Study (Group) (Figure 6)

Figure 5: Process Charts: Stage 1
Source: Authors

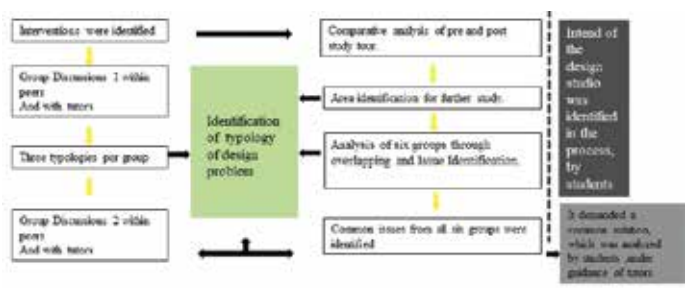

Figure 6: Process Charts: Stage 2
Source: Authors

4.1.4 Stage 3: Solution (Group) (Figures 7 and 8) Exercise 3-Common Proposal given by students (Source: Students of Semester VIII-2023-24)

1. Developing flexible event spaces and cultural venues
2. Pedestrian-friendly infrastructure – walkways, public squares
3. Artist retreat
4. Cultural centers
5. Craft markets
6. Interpretive signages
7. Cultural performance spaces – amphitheaters, platforms
8. Cultural themed heritage trails
9. Artist residencies and workshops
10. Art and craft centers
11. Vocational centers
12. Interpretation center
13. Art Gallery
14. Sports Complex

Figure 7: Process Charts: Stage 3
Source: Authors

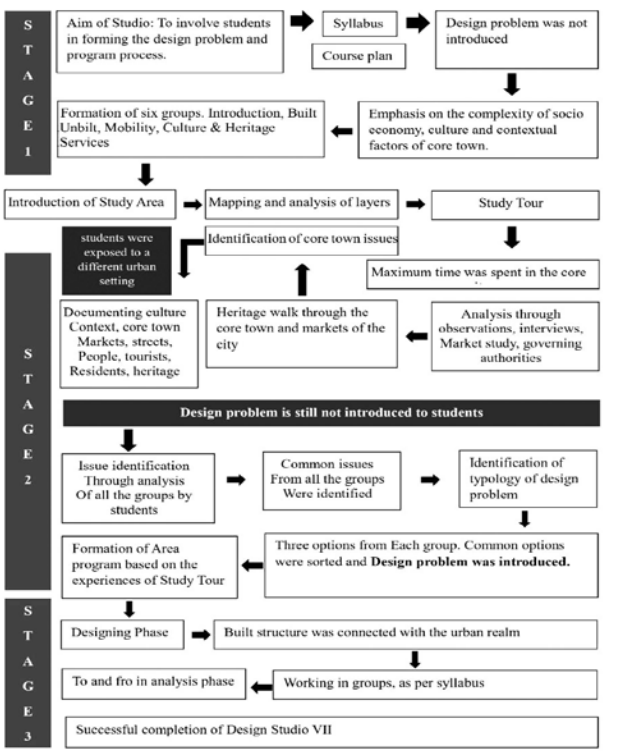

Figure 8: Process of Studio VIII
Source: Authors

5. Results and Discussion (Table 3)

From the commencement of the studio, the course plan gave a specific direction. Initially, the students took time to grasp the design problem. With multiple examples and case studies, students were taken to a certain level, where they started to get involved in the studio. The first phase of the studio was conducted according to the course plan. Here, the processes were broken down and then implemented in the studio. The allocated time and relevant references provided according to the course plan were sufficient. The title of the design problem was never disclosed to the students during stages one and two, as this helped them to study all the aspects of the core town. Without setting any design problem till the middle of the semester, students studied and identified, analysed all the issues and aspects of the study area. The reason was to prepare them to handle any design problem in the future. This helped them with a better understanding of the intention of

Table 3: Learnings from Studio VIII
Source: Authors

Course plan	Experience	Observations	Learnings
Stage 1-Introduction of syllabus and understanding the intent of it.	Students were made aware of the typology of design problems	Mapping and analysis were new concepts for students. They responded positively.	
Introduction of mapping, and documenting city through layers.	The division of groups for mapping ensured smooth running of studio	Time to time stage wise presentations with peers ensured development of communication skills, and improvisations.	The title of the groups were broken down further, which led to hassle free running of studio.
Issue Identification	All groups were supposed to work upon observations, inferences, conclusions, and Takeaway	Issues were identified by students which included some common problems, from all the groups.	Students involvement in formation of design problem, enabled them to work with tutors, and a sense of responsibility was developed in them.
Stage 2- Study Tour	Maximum time in core town area. Analysis through interviews, markets, streets, people, context, demand, supply.	Heritage walk helped to connect with the actual residents of core town.	Involvement of local experts, architects helped in connecting the dots of analysis.
Problem identification	Students worked collectively, after the comparative analysis, to identify the typology of design problem	As they were not introduced to the design problem at the commencement of studio, their mind was a clean slate, and they thought of various opportunities of designing.	Frequent common Discussions with students, tutors proved fruitful for the studio.
Design Solution	Common solutions were identified, which included all the aspects from every group.	Students dived into the design phase enthusiastically, as they were involved in the problem formulation phase. Sense of opportunity, responsibility and process of designing were learnt by them.	They completed the designing phase within 1 month, as they understood the intend of syllabus, and the process of identifying the design problem.
Design problem was formulated by students, under the guidance of tutors, at the end of phase 2,after 2 months of the commencement of Design Studio VII.This was the first experience for them being involved in the evolution phase of Design.			

the studio. Usually, when a particular design problem is introduced in a studio of a particular year, students only focus on the type of building they need to design, in that semester, rather than focusing on the aspects of designing that type of building. Students seldom acknowledge the purpose of a certain design studio. The thought and understanding of the tutor behind introducing a certain design problem rarely reach students. Till the third year, the design problem is introduced on day 1 of the studio, and in some cases, students are involved in setting the design problem. But, generally due to scarcity of time, and understanding of students to reach that level, it becomes rarely possible for students to be involved. Hence, design tutors themselves decide the type of problem and the design program to be carried forward in that particular year. The site is also decided by tutors. They follow the top-down process, i.e., the tutors decide and design, and students follow the process.

In this studio VIII, we wanted to avoid that, hence time was designated for students, and they were directed towards the type of problem. They were given the liberty to decide the design problem, based on the analysis done in stages one and two. The thought was to involve students in the design process and make them independent before entering into the last semester and working on a thesis. It also gave them a sense of responsibility for curating a design problem and designing a solution for it.

In the second phase of the studio, after the study tour, during some instances, which included master plan preparation, students needed more time for clarity and designing, so the course plan was revised again. Then, a buffer of 2 weeks was created between a completed set of drawing submissions and the final Jury. Here, students worked on their presentation skills and model making. The final phase of the studio concluded with acceleration in students' work, as they had a better understanding of the intention of the studio.

6. Conclusions and Recommendations

The journey of architectural education has changed and evolved, based on the industry's needs, within an ever-changing society. In Architectural Design studios, the schedule with the dates of every milestone at various stages is shared with the students. These milestones are usually 2-3 weeks apart; hence, students become complacent in the meantime and begin to work just 1-2 days before the submission deadline. They are not involved in the entire duration of the studio but work only in the end, just to meet the deadline. In all probability, they use shortcuts, duplication and readymade work from the internet resources. However, a dynamic course plan may keep them on their toes, engrossed and involved in every stage. Architectural education, especially the Design studio, can make a difference by reducing the gap between practitioners and the education.

The course plan was adjusted to achieve specific, smaller targets and keep students involved at all stages until the completion of design proposals. This will eventually help students to take charge of their future practices. In this case, students started to explore the thought process behind introducing them to core town issues. This led to the involvement of students in structuring the design problem with the tutors. Introspection and analysis of students led to various options as solutions to the core town issues. Discussion within peers and with tutors led to the finalisation of the design problem, in the middle of the semester. The design program was formulated by students, based on their understanding of the study, with the tutor's guidance. During the actual design process of the structure, the background study and clarity of the intention of the studio helped students to accelerate the design process within a very short period. Even if the final stage of designing was compressed, it was still completed because the above process was followed in the studio, and the course plan acted as a tool to better understand core town issues, in the VIII semester of B.Arch.

Overall discussion concludes that the course plan is the appropriate tool for understanding the design problem and running the design studio successfully. Students needed more time during the design phase of the master plan and site plan. If the pre-study work is rigorously conducted and guided, it becomes easier for students to understand the thought behind the design problem. Regular, timely discussions with the students proved effective during the process, as this became a learning even for the tutors. Understanding students' psychology and background is a significant aspect to be considered while conducting a studio. A syllabus is a theoretical framework and a course plan is a practical tool to implement the syllabus. Every college can interpret the syllabus for every batch differently. The syllabus gives the guidelines for the factors that need to be covered in the studio. Syllabus is a destination and tutors are free to interpret it in the way they want the studio to be held, in that semester. As, syllabus acts as the destination, how to reach the destination is decided by the course plan. Here, the course plan is significant because even if the syllabus is the same for all the colleges in the university, the journey of

the studio is decided by the course plan. The same syllabus can work for all the classes of Fourth Year, but the same Design Course plans will function improperly for all the batches of Fourth Year. The course plan has acted as a pedagogical tool to better understand core town issues in the VIII semester of B.Arch.

6.1 Final Design Proposal (Sample Work) (Figures 9 and 10)

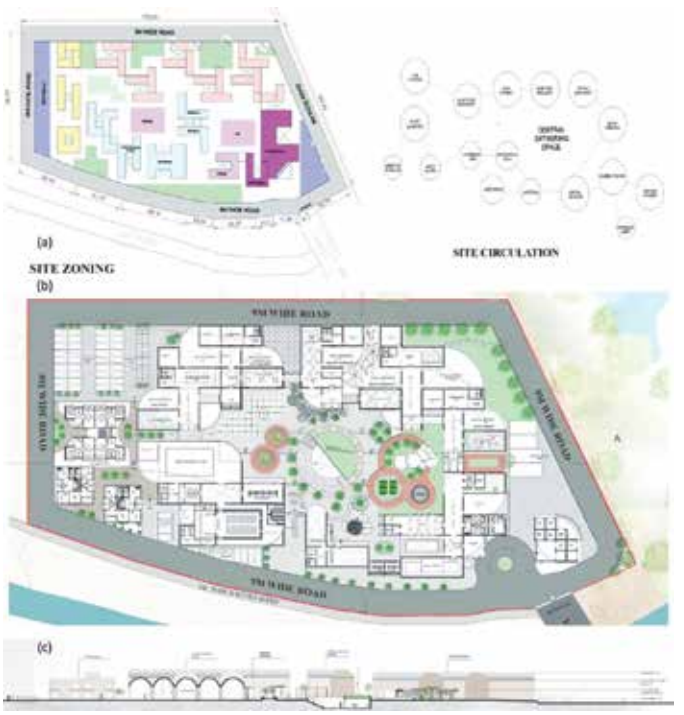

Figure 9: (a) Zoning and circulation (b) Masterplan (c) Site Sections (Sample)
Source: Students of Semester VIII-2023-24

Figure 10: Physical Models (Handmade)
Source: Students of Semester VIII-2023-24

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RESEARCH PAPER

This research paper was presented at the IIA ANVESHAN Research Conference held at MCAP, Thiruvananthapuram, Kerala, 29-31 August 2024, under Stream: Celebrated Past.

Reviving Traditional Water Management Systems

of Eastern Vidarbha through Community Engagement

By Nikita Mahale Sakpal and Rashmi Tapke

Abstract

Water harvesting in India is a centuries-old practice, rooted in the ecological and cultural landscapes of its diverse regions. These traditional systems reflect generations of indigenous knowledge and offer sustainable solutions for contemporary water management challenges. In eastern Vidarbha's *Zadipatti* region, particularly in Bhandara (Figure 1b) district, the Kohli community historically constructed over 15,000 tanks and *baories* to harness rainfall, despite the region receiving 1200–1500 mm annually. Over time, many of these systems deteriorated due to reduced community involvement and modernisation.

This study examines the successful revival of traditional water management systems in two villages: Aashti and Ramtek (Figure 1b) in Maharashtra, along with community participation. Aashti features a cascading system of 76 interconnected tanks, while Ramtek showcases an intricate model that integrates surface and groundwater through a series of tanks, wells, *baories, kundis*, and waterholes. These systems collectively retain 60–70% of runoff and support ecological balance.

The analysis underscores the effectiveness of community participation in restoring these systems, which enhance water security, biodiversity, and climate resilience. Traditional wisdom, when blended with modern practices and institutional support, the study proposes a (community) participatory conservation framework that is both sustainable and replicable. Reviving these systems offers a path toward resilient and inclusive water governance in India.

Keywords: ***Traditional System, Water Harvesting, Community, Ecology, Conservation***

1. Introduction

India's economy is largely based on its growing agriculture and industries. This reliance of the two is

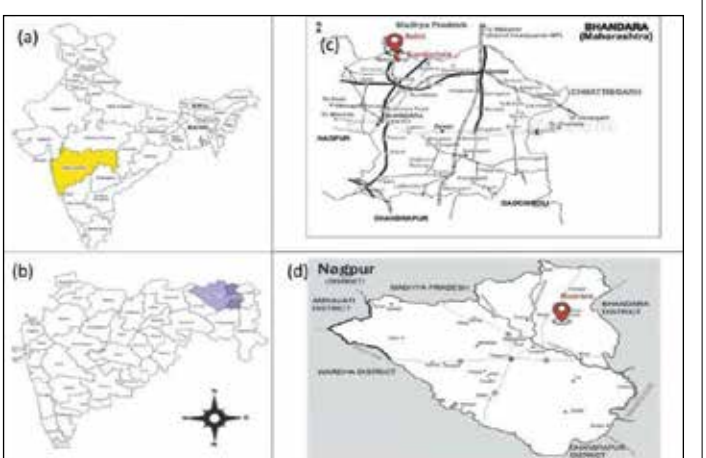

Figure 1: (a) Map of India, (b) Map of Maharashtra, (c) Map of Bhandara with Aashti and Sundertola locations, (d) Location Map of Ramtek
Source: Google Maps; www.jatland.com (Jatland)

intricately tied to the monsoon rains, which play an important role in determining the success of crops and, consequently, the nation's economic stability. However, India faces a water shortage owing to many factors like scarcity and pollution. Though the country has 18% of the world's population, there are only 4% of the total water resources (NITI Aayog Report, 2017), and India has many parts that face water shortage.

The water management traditionally practiced across the country has evolved over the years, adapting to the diverse ecological and cultural landscapes. Two such villages of Aashti and Ramtek, in the Vidarbha region in Maharashtra, have their economy based on agriculture, which is largely based on monsoons. Despite good rainfall, the area faces water scarcity. This led to reviving the age-old traditional water management system that ensured a year-long, continuous water supply, without affecting their day-to-day activities.

Reviving age-old traditional water management systems is not only essential for conservation, but they can also help in the following ways (Mishra, 1993):

1. Sustainability: Traditional systems are inherently sustainable, relying on natural processes to recharge groundwater, thus maintaining ecological balance.
2. Adaptability: Since they are adapted to the local topographic and climatic conditions, they are resilient to local environmental and climatic changes.
3. Cost-Effective: These traditional methods require less investment compared to the modern ways.
4. Community Engagement: Originally, these systems involved community participation, thus reducing overhead costs and giving a sense of involvement and ownership. Reviving these systems can strengthen the communities together by encouraging the use of local practices.
5. Control on migration: The migration of mostly the young generation from the villages to nearby cities for better employment can be controlled

Clause 4.1 in India's National Water Policy, 2002, states that reforms in the water sector should have consideration for the existing traditional ways and also an emphasis on community-based participatory management under clauses 6.8 and 12.

This research studies the water system traditionally followed in two villages of Aashti & Ramtek, which can be useful in creating a successful prototype.

1.a Aashti lies in the Bhandara district of Maharashtra, with a large part being occupied as agriculture owing to its highly fertile land. The main crops of the village are paddy, wheat, and sugarcane depending on water for their irrigation. Jaggery making is also one of the chief occupations of the people at Aashti. Owing to its topographical conditions, a tank system was developed to collect the overflowing water, ensuring 80% of its water is used for irrigation, domestic and other miscellaneous purposes by the villagers.

The chronology history of the ownership and management of these tanks have been detailed out in Table 1. In its olden times, the *Kohli* community in the village had developed a water harvesting system to ensure self-sustainability. Later, under British rule, the ownership and control of the tanks were handed over to the *Malguzars* for the collection of taxes.

The village has a cascading network of around 76 tanks, including the seasonal farm ponds. These tanks (Figure 2a,b) were built at levels that are interconnected with an overflow system, resembling a cascade. The water from the bigger source tank is released to "*Kutans*"

Table 1: History and Analysis
Source: Author

	Gond Period	**Colonial Rule**	**Post-Colonial Rule**
Ruler	Gond Kings	British Rulers	Indian Government
Ownership	Community	Malguzars under British Authority	State Irrigation Department
Management	Malguzars, along with the Community	Malguzars	State Irrigation Department
Maintenance	Community	Community	No maintenance to centralisation

Figure 2: (a) Water Tank & Tudumchi Payari, Aashti Village; (b) Aashti Village - Kutan & Pat (c)&(d) Kapoor baoli- water tank, Ramtek
Source: Authors

or the smaller tank, which are then dispersed in various directions by the use of "Pat" or the irrigation channels. The distribution of water with the pats ensures a wider spread of the collected water. Ultimately, the downstream or the stream on the lower level receives cascading water from the upper streams.

Owing to the change in pattern of the ownership by the Britishers, and the little know-how by the government after independence, the earthen bunds and the channels were converted to concrete ones. This resulted in no percolation and absorption of the excess water, thus failure of the system. These water harvesting systems are thus lying unused and deteriorated. This resulted in worsening the condition further. Though now, with the intervention of agencies like NAAM foundation, there have been efforts to de-silt and widen the rivers along with making recharge pits, which ensure the collection of water that can be used by the villages for multiple uses.

1.b Ramtek Village is located in the Nagpur district, Maharashtra, which gave its name to the Ramtek model of water harvesting. The major occupation of the people in the village is agriculture. The Ramtek model is similar to the model at Aashti, which is a network of groundwater and water bodies like the tanks and rivers.

The method conserves the overflowing water along with various water bodies like the wells, *baolis (Figure 2c,d), kundis*, and waterholes, ensuring the water can be conserved across the landscape. This model can be successful in conserving up to 60-70% of the water that would otherwise overflow. These water bodies were usually maintained by the local "*Malguzars*". It is a network of groundwater and surface water bodies and is constructed and maintained mostly by the landowners, also known as the "*malguzars*" of the region. The Ramtek model is a series of tanks that are connected by both surface and canals running underground, forming a chain that extends from the foothills to the plains. After the tanks located at the foothills get filled to their capacity, the water flows down and fills the successive tanks and ends as a small pool.

1.1 Aim and Objectives

The aim is to understand the need for revival of the traditional water management system and its adaptive reuse in the current times. The study involves examining two villages of Aashti and Ramtek in Maharashtra, which have successfully revived their traditional water management systems, resulting in significant ecological improvements.

2. Literature Review

In her paper, author Namrata Vishwasrao (Vishwasrao, 2010) studied traditional water conservation methods in the Vidarbha region of Maharashtra. She mentions how traditional knowledge and practices can be integrated and used in planning at the national and regional water. The study mentions the opportunities and challenges, institutional structure, and government initiatives, along with the co-management initiatives.

"After years of acclimatization, the tanks have become an integral part of the ecosystem, which supports numerous species of fish, amphibians and reptiles, insects, and water birds. Water plants and rushes also grow along the tanks and all these resources are sustainably harvested and used effectively by the local population."

The research by Manish Rajankar (Rajankar, 2018) is based on his studies in the areas of Bhandara, Gondia, Gadchiroli, Chandrapur, and Nagpur districts, known as Zadipatti. The author has documented the system of the network of tanks along with its structure and features.

Raghunandan A. Velankar (Velankar, 2011) talks about the changes in community-based management at Gondia District in Maharashtra. The author has studied the pattern of change over the last 100 years, which is an effect of policy initiatives at the national level. The policy initiatives have a positive effect, helping a disadvantaged section of society to be recognised as a proficient user group.

The authors (Matham et.al., 2023) have stressed a community-driven participatory model to promote the efficient and sustainable use of groundwater in a South Indian village, using system dynamics modeling as a tool. The research emphasises collective decision-making, engaging local stakeholders to understand groundwater dynamics and co-develop strategies for sustainable management.

The authors (Singh, Pandey, & Goswami, 2021) elaborate upon how traditional Indian water management practices that are distinctive to the regions and adaptive to the climatic conditions are not just practical, but also socially inclusive and ecologically balanced. The author further details on participation of the community, cultural respect, and knowledge preservation along with revival practices.

3. Methodology

The region selected for the study is Vidarbha - to understand the current situation and the techniques followed. Primary and Secondary methods of data collection were used for the study as follows:

Primary data collection involved:

1. Visit to the two villages of Aashti and Ramtek to understand the following:
   a. Geographical region
   b. Socio-Cultural setup
   c. The main occupation of the locals
   d. Administration
   e. Population of the villages
   f. Agriculture and Irrigation practices
2. Observed, studied, and photo-documented the revived water management system.
3. Interview of the locals to understand their requirements and the challenges faced.
4. Interview of the experts in the field
5. Visit to neighbouring villages that need similar interventions

Secondary data collection involved:

1. Study of the regulations and National Water Policies
2. Study of research papers on the topic of water management systems in India
3. Study the work done by foundations like NAAM and Paani across Maharashtra, which revive traditional water management systems with external interventions wherever required.

4. Data Analysis and Findings

Stage I: The two villages of Aashti and Ramtek were visited to understand the following:

Case I: Aashti is the second largest taluka, after Bhandara, in area. Aashti lies in the watershed region of the river Bawanthadi on the border of Maharashtra and Madhya Pradesh. The average rainfall in the region is between 1100 to 1200 mm. The high fertility of the land is a result of its ideal location. The wells in the village are either Gram Panchayat or privately owned. Apart from the wells, the villagers also rely on water taps and hand pumps set up through the State Government water supply schemes.

According to the 2011 census, the population of Aashti is 2,43,607, which comprises of mixed population of people belonging to the *Kohli, Brahmin, Dheewar, Rajput, and Muslim* communities. The traditional tanks were built by the *Kohli* community, constituting 75-80% of the population. *Gond Rajas* introduced the *Kohli* community to the area to build tanks, ensuring a water supply for the people and promoting agricultural development. To enhance revenue, the *Gond* kings promoted the cultivation of cash crops (Figure 3a) in the heavy rainfall regions of eastern Vidarbha. Crops like commercial paddy and cultivation of sugarcane along with jaggery (*gud*) making were encouraged. The *Kohlis* are the primary landholders and are an agriculture-based community

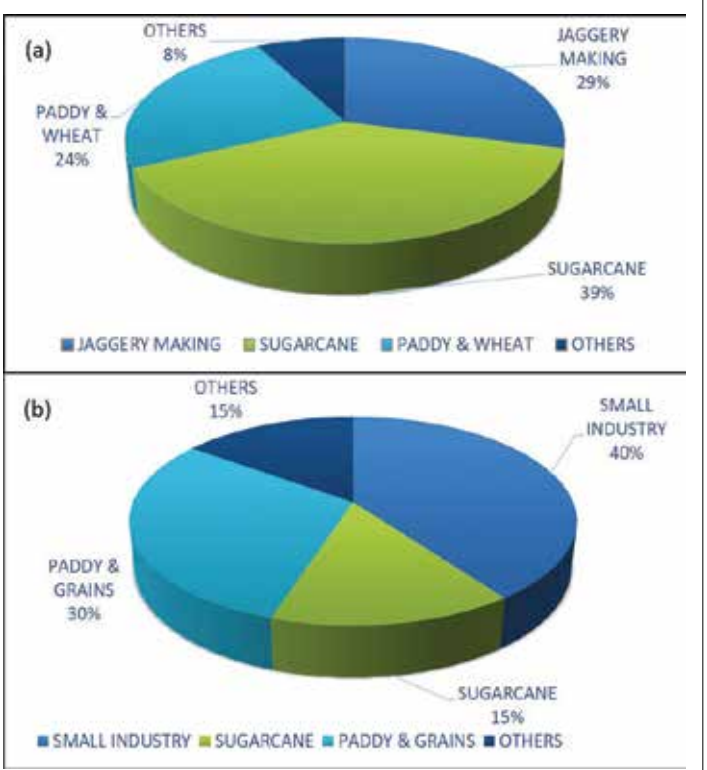

Figure 3: (a) Agricultural produce at Aashti, (b) Agricultural produce at Ramtek
Source: Authors

in the region. This community still has the knowledge for nuances for tank building, like the site selection with the least bunding required, the construction of the tanks and channels, or the *pat*.

The livelihood of the people is still largely based on agriculture, with paddy, wheat, and sugarcane being the main crops. All of these crops are dependent on a high amount of water supply. Over time, the water availability has varied due to multiple reasons. Owing to varying water availability, soil type and conditions, and land size, there is no fixed farming pattern observed by the farmers. The *Dheevar* community depends upon fishing in the traditional way, using old fishing techniques for their livelihood. The landless villagers survive by working as farm laborers. A commonly observed source of livelihood for the landless is the jaggery-making activity, with jaggery production being a small-scale industry in itself.

The percolation tank (Figure 4c) is constructed at different levels by putting an earthen embankment, which is a few metres high at its lower end. They are interconnected (Figure 4a) by an overflow system to trap the runoff.

"*Tudum*" is the mechanism to draw water into the "*pat*" from the tank for irrigation. A tunnel is constructed across the bund using stones over which a step-like structure, called "*tudum chi payri*" (Figure 5a,b).

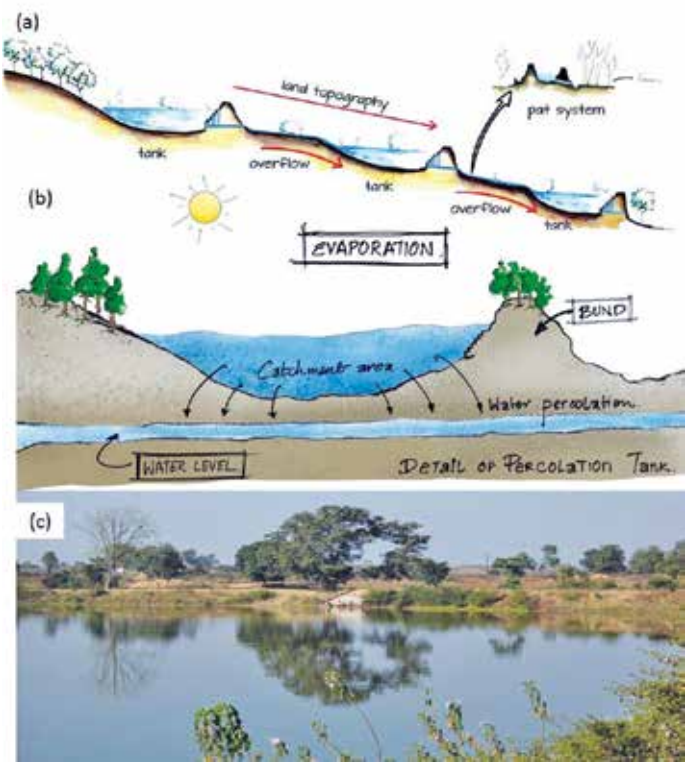

Figure 4: (a) Cross Section of Interconnected Tanks, (b) Aashti Village - Kutan & Pat, (c) Percolation water tank with Tudumchi Payri at Aashti
Source: Authors

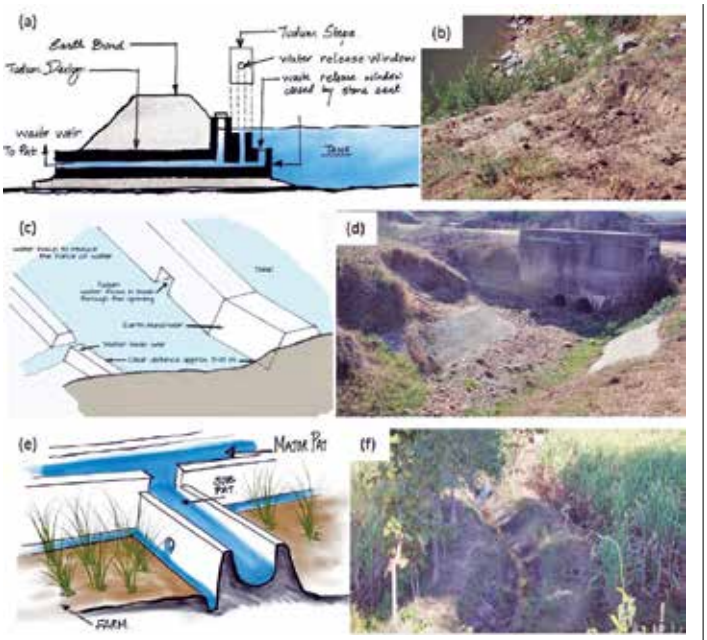

Figure 5: (a) & (b) Tudum chi payri at Aashti; (c) Aashti Village – Kutans; (d) Actual photo of Kutans (e) Aashti Village – Pat; (f) Actual photo of Pat
Source: Figures (a), (c), and (e) – Adapted by authors from Vishasrao N. (2010); Figures (b), (d), and (f) – Authors.

Every step has a hole, called "*daccha*". Depending upon the level of water, the respective hole in the step is opened and the water is released. There are a few parts of the village that use this system; however, it is in a dilapidated condition and needs repairs.

The water from the bigger source tank is released to "*Kutans*" (Figure 5c,d) or the smaller tank, to avoid the distractions of *pats* due to the sudden release of water from the bigger tank and to ensure equal distribution of water, which is then dispersed in various directions by the use of "*pat*" or the irrigation channels (Figure 4b).

Given the agricultural needs, the traditional water harvesting system was made to collect maximum water and utilise it for successful irrigation with a wider spread. The overflow system formed an interconnection with the overflow from the uppermost tank, filling the tanks constructed downstream through *pharas* or *pohar* (waste weir to remove surplus water), and the *pat* (Figure 5e,f).

With changing ownership patterns, presently the tanks are taken care of by the Water Committee (Figure 6), which functions independently of the Gram Panchayat. But of late, there is dissatisfaction amongst the villagers about the mismanagement by the committee. This leads to the neglect and dilapidated condition of the *tudum*. Also, people have an individualistic and self-interested approach, which reduces community feeling. With the new

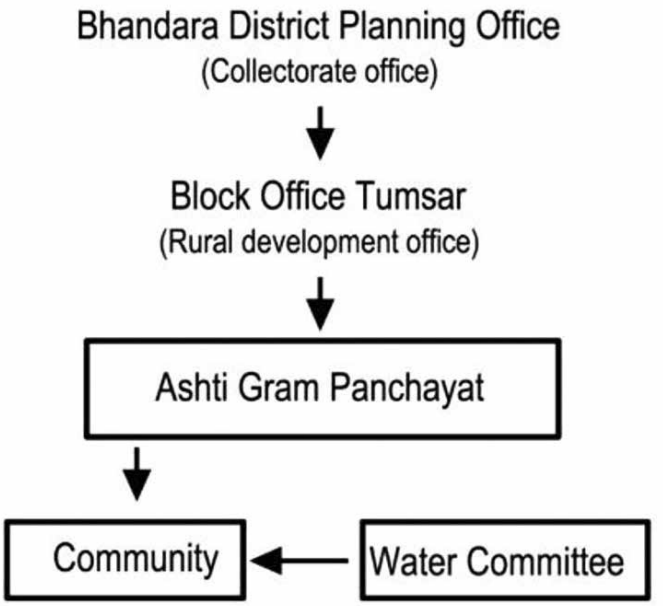

Figure 6: Institutional Hierarchy
Source: Vishwasrao, 2010

sources and techniques available, people are losing interest in tank systems and relying more on using water pumps.

Case II: Ramtek lies in the Nagpur district of Maharashtra, with a picturesque topographical setting. It is situated at the foothills of Ramgiri, which is the last range of the *Satpuda* mountains. It is bounded by Madhya Pradesh to its North, and Bhandara district of Maharashtra to its east. To the North of the village are the majestic Ramgiri and Kaikai hills dominating the landscape, while the town gently slopes southward, surrounded by a chain of lakes. The annual rainfall of Ramtek varies between 1100-1200 mm.

Being an important town in the Vidarbha Region, the town of Ramtek shows an organic growth from the historic times with communities from diverse religious and cultural backgrounds, like around the Hindu temple, Jain temple, and the Ambala lake. It is a renowned pilgrimage hub of Vidarbha, with good potential to be a place of tourism. With the presence of forests, water bodies, and black cotton soil, the area is rich in natural resources. Since the historic period, the people of Ramtek have done agriculture and allied activities for their livelihood.

The population of Ramtek is 22,310 as per the 2011 census of India (GOI, Census 2011), which includes people from different religions. Owing to the natural sloping terrain, the fully evolved Ramtek system was designed in the older days. The cascading system supported by the high-yielding wells and other structures like the *baolis, kundi* and waterholes was designed to conserve and collect the rainwater as much as 60-70%. The "*malguzars*" or the landowners used to construct and maintain them earlier, till the British rule. The Ramtek system, as it is known, works on the cascading effect of water overflowing from the topmost tank to the next tank in sequence. The overflowing water thus flows to the *pats* that in turn are utilised for better irrigation.

One of the popular *Kapoor Baoli* (Figure 7) at Ramtek is a structure used for water conservation apart from religious activities. The strategic location of the *baoli* ensures that it is always water-filled.

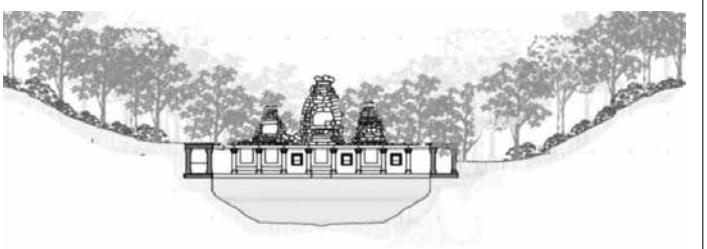

Figure 7: Cross Section at Kapoor Baoli
Source: Khilnani, 2018

Both villages have contoured land that helps in developing cascades of water that are interconnected. The tanks initially were built specifically only for irrigation and agricultural use (Figure 3b). However, after years of being a part of village topography, they became a vital part of the ecosystem, becoming a breeding ground for many waterborne animals and fish. This gave rise to fisheries, thus contributing to the economy of the village, especially for those without any land and low land-holding families. Thus, tanks were slowly integrated into Vidarbha's setup.

The interview with locals speaks about the water scarcity issue they face owing to the depleting water harvesting tanks. The water shortage affects their day-to-day lives, and it is then difficult for them to provide water for small-scale industries, agriculture, and livestock, apart from others (Figure 8).

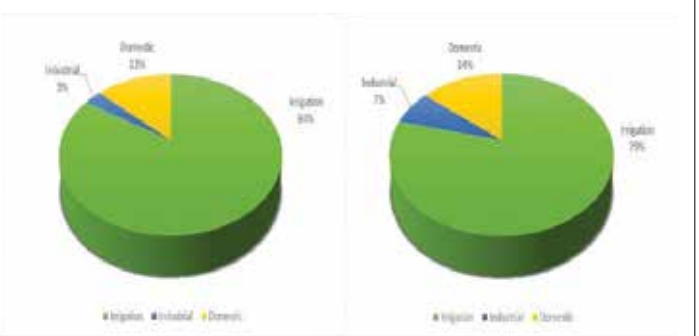

Figure 8: (a) Water uses at Aashti, (b) Water uses at Ramtek
Source: Authors

Post-independence, the responsibility of the tank system was handed over to the jurisdiction of the State Irrigation Department from the abolished *Malguzari* system in 1955. The government officers lacked knowledge and understanding of the tank systems. Also, changes in the design, like changing the mud pat to concrete, resulted in reduced percolation of water into the ground. The newer technologies and advancements resulted in neglect and the eventual bad condition of the tank system. Changes have been observed in this arrangement of tanks, and the villagers have been drawing more water from the rivers.

Case III: The neighbouring village of Sundertola, in the Bhandara district, was also visited. Bhandara, called the "lake district", falls in the tropical wet and dry climatic zone. The entire impervious terrain of Bhandara is suitable for adopting the tank system.

Case IV: The NAAM foundation has done credible work at village Pandhari in Aashti tehsil (3 km away from the sub-district headquarters Aashti at Beed). It was observed that in spite of a moderate groundwater level during monsoon, water scarcity during the summer season is scarce. Over the last 20 years, the water table has fallen by 2 to 3 meters every year. With their initiative, along with the Gram Panchayat, post the Covid-19 pandemic, NAAM Foundation recommended the following two solutions –

1. Construction of a "recharge pit" in the main river with the channels connecting the main river. Reviving the age-old tradition, the "recharge pits" (bore wells) were dug, along with deepening the small area around the bore wells while filling up that area with stones or with a sheet.
2. The depth of the rivers was increased, and their banks were widened, thus increasing the water holding capacity of the rivers.

Stage II: With depleting water tables and ever-growing demand for water for innumerable activities, the government has taken cognizance of the same and introduced many national water policies. A few of them are as follows:

1. *Jal Shakti Abhiyan (2023*): With the slogan "Catch the rain, where it falls, when it falls" the states and stakeholders are encouraged to construct suitable Rain Water Harvesting Structures (RWHS) tailored to the climatic conditions of the region and sub-soil strata before monsoon. The campaign emphasises restoring traditional methods alongside modern techniques for a sustainable water supply.
2. *National Water Policy (2012*) encourages to proposal of a framework for the creation of a system of laws and institutions and a plan of action with a unified national perspective, as a solution to the existing situation
3. *"Paani Bachao, Paisa Kamao"* (Save Water, Earn Money) scheme encourages farmers to reduce groundwater usage.
4. *National Water Mission*; The objective of NWM is 'Conservation of water, minimising, promoting more fair distribution of water—both among and within States—through integrated water resources development'.
5. *The Jal Jeevan Mission (JJM)*: Launched in 2019 to provide a functional tap connection within the premises of each rural household in India by 2024.
6. The mission addresses SDG target 6.1, which focuses on providing safe and affordable drinking water to all, ensuring universal and just access by 2030
7. *Ministry of Jal Shakti*: The Government created the Ministry of Jal Shakti in May 2019 to consolidate interrelated functions of water management.
8. *Atal Bhujal Yojana (ABY)*: The scheme seeks to enhance the groundwater resource management in such areas, which account for about 37 percent of such blocks in the country.
9. *Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)*: It is a centrally sponsored scheme (core scheme) launched in 2015. The centre-state share will be 75:25 per cent. In the case of the north-eastern region and hilly states, it will be 90:10.
10. *National Aquifer Mapping and Management Programme (NAQUIM)*: Under NAQUIM, groundwater aquifers have been mapped and management plans have been made for 80 percent of the country.
11. *Bureau of Water Use Efficiency (BWUE)*: It catalyses enhancing water use efficiency across multiple sectors, including irrigation, drinking water supply, power generation, and industries throughout the country.

5. Results and Discussion

The data findings concluded by emphasising the advantages of water conservation systems (Figure 10). With the water scarcity, many of the villages struggle to survive with the water collected during the monsoons. The water is hardly sufficient for four to five months, and is usually over by January or February. This made it difficult for the locals as even drinking water was difficult to get, let alone for the other activities. The lack of water potentially ruins the harvest, thus increasing the financial burden on the farmers. The perennial rivers were the next water source to the areas that were close to the rivers, but the other areas still struggled. This resulted in repeated annual drought-like situations, which gave them no options but to call for water tankers. The deterioration of the age-old traditional water harvesting methods made them defunct, thus affecting the water table of the area also.

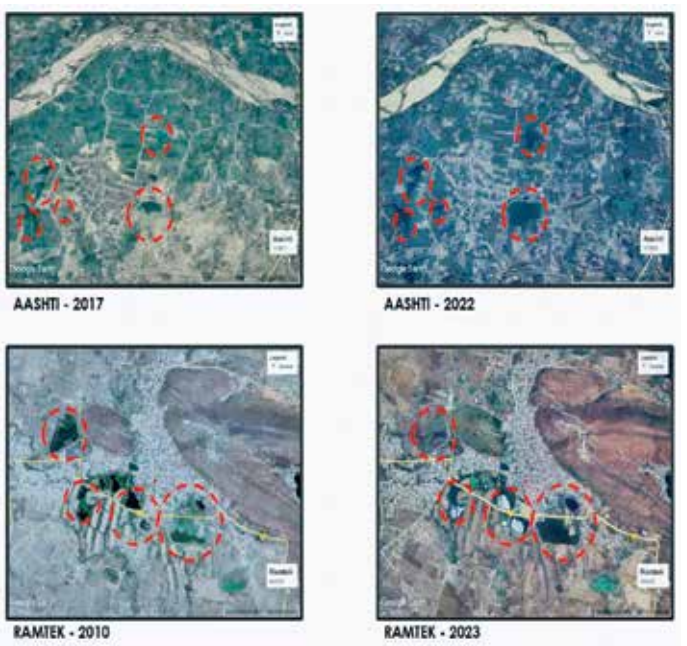

Figure 10: Actual images of the changed village landscape
Source: Google Earth

The work done by NAAM Foundation and Paani Foundation in the state transformed the village landscape, bringing approximately 50–100 hectares under cultivation and helping the local economy begin to recover. This ensures no water scarcity during the summer season. This has effectively improved the situation of agriculture and farming in the region, along with the dairy and gud-making industry. The sugarcane production has improved by around 2.5 times from what it was earlier, thus improving their income.

The Gram Panchayats in the villages are the bodies that can take the lead to involve the locals and the community to give a feeling of ownership and responsibility to revive the traditional water harvesting systems (Laskar, 2022). Involvement of external bodies like NAAM foundation has also been involved in Aashti to de-silt and make recharge pits.

The traditional water systems of Ramtek and Aashti showcase an interwoven relationship between ecological sustainability and community participation, which can be replicated in resilient water management. Their success lies in ecological knowledge and community collaboration, making them relevant for contemporary water governance and strategies for climate adaptation.

6. Conclusions and Recommendations

Groundwater depletion is becoming an alarming issue with each passing day, giving more importance to the study of traditional water harvesting and conservation methods. There has to be more collective and community action taken for the same.

Reviving traditional water management systems is a battle to be fought against socio-economic challenges and involves learning the knowledge of the locals who have proved in the past that these systems can be successful. The government and the national policies can facilitate the cause, thus involving more people and regions.

Comparative analysis of such villages with those facing water scarcity highlights the potential of reviving these traditional systems to transform regional ecology. By embracing these age-old practices, communities can ensure sustainable water management, mitigate scarcity, and preserve ecological balance. Additionally, this study emphasises conserving these systems, along with the importance of maintaining and revitalising practices for traditional water management and contemporary ecological sustainability.

Engagement of the community is an essential component in the restoration and long-term sustainability of traditional water management systems such as the indigenous system at the villages of eastern Vidarbha. Historically, these systems were developed, managed, and maintained through collective community action, ensuring fair access to water and inculcating a strong sense of shared responsibility and governance.

However, the gradual centralisation of water governance, along with the widespread adoption of modern infrastructure, has led to the decline of these community-managed practices. Revitalisation efforts must therefore prioritise the reintegration of local stakeholders—particularly the youth—into participatory planning, decision-making, and maintenance processes. Such involvement ensures a sense of ownership, encourages incorporating traditional ecological knowledge, and supports locally tailored solutions to contemporary water challenges.

These systems have proven that if maintained well, they can stand the test of time with some modern interventions to improve efficacy. Being simple to construct and use, these systems last longer and can easily be repaired whenever needed. Promoting participatory water governance requires fostering awareness through inclusive dialogue, shared learning, and stakeholder engagement. To be effective, such participation should be tailored to the local context and supported through ongoing facilitation by governmental institutions or non-governmental organisations like NAAM and Paani Foundation. These collaborative frameworks play an important role in achieving long-term sustainability of water resources (Figure 9 a,b).

Water harvesting also contributes to healthier ecosystems and enhanced biodiversity, facilitating the revival of native flora and fauna that may otherwise decline due to adverse environmental conditions. When integrated with participatory governance frameworks, these practices not only ensure ecological restoration but also empower communities to become active guardians of their natural resources. Good collaboration between traditional ecological knowledge, community involvement, and institutional support creates a good foundation for sustainable water management and long-term environmental resilience.

Moreover, participatory approaches reinforce social cohesion and contribute to more adaptive and resilient water management frameworks. Recognising and empowering community participation is thus crucial not only for preserving traditional water systems but also for advancing sustainable water governance in the face of growing environmental and societal pressures.

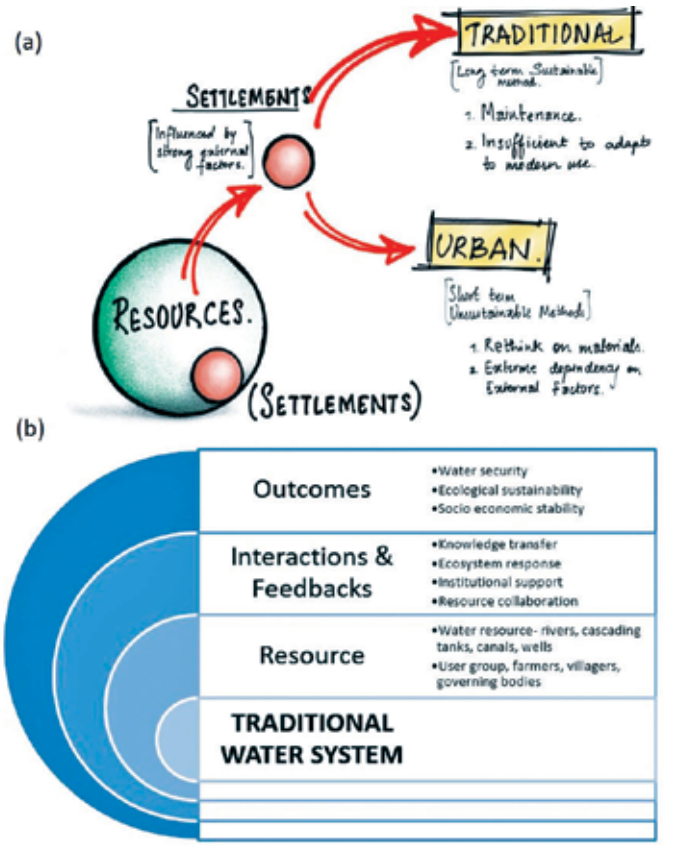

Figure 9: (a) Influences on settlements; (b) Socio-environmental impact of using traditional water systems
Source: Khilnani, 2018

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An annual initiative by AVANI Institute of Design, Kerala, the Avani Essay Prize is envisioned as a platform to nurture reflective and critical writing among undergraduate students of architecture, planning and design across the world. The 2024 edition invited participants to engage with the theme *Emerging Landscapes*, encouraging them to interrogate the layered meanings of landscape as ecological, cultural, social and urban constructs. The competition sought essays that reflected on contemporary transitions—spanning climate, technology, and society—and examined how spatial practices might respond to and reimagine these evolving conditions.

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WINNING ENTRY

Adaptive Reuse: The Landscape of Today is the Landscape of Tomorrow

By Akila Jayaraman

On the canvas of the world, buildings generate different spatial organisations, host multiple functions and serve as a vessel for people to interact with each other. The curation of the built environment has created many efficient and beautiful structures, hierarchies and ideas. Throughout time, the environment has been imprinted differently. Now, it is important to evaluate the balance between civilisation and nature.

Many designers have looked to the Urbanism movement spanning throughout the 1900s where many architects laid out plans for how their cities should be organised. However, many of these projects were not realised through actual construction, and when they were, it was not usually very effective. For example, Le Corbusier's *Ville Radieuse* was his idea for a utopian version of city planning in the city of France. His goals were to "provide effective means of communications; provide large amount of green area; provide better access to the sun; reduce urban traffic" (Montavon et al. 2006). This plan was very ineffective because it did not consider the existing city, the small housing units, and natural light did not flow better than in a traditional design. When this project was used as inspiration in places like Chandigarh, Punjab, and Algiers, Algeria, it was still not a good design strategy because it did not account for the lifestyles, societal systems and climate of these regions (Frampton 2020). Ultimately, urban planning is a discipline that is very site-specific, and changing existing structures can create negative effects within a local community, increase climate concerns, and disrupt the urban fabric.

One major way that people can expand urban structures and be cognizant of the environment is *adaptive reuse*, which is when a building with an "existing form can host new functions" (Robiglio 2016). This is valuable from the lens of sustainability as the process of demolishing buildings and creating a new one strains the environment more than the energy consumption of expanding upon an existing building. Additionally, it does not disrupt the topology of a city. As will be evaluated by three case studies, adaptive reuse that respects a building's context is a highly effective method for the future of urban construction because it presents new design opportunities, respects cultural architectural attributes, and can bring people together in unexpected ways.

Adaptive reuse requires architects to take an existing construction system and expand upon it in a new way. This can present many challenges because construction methods change over time, and it can be a difficult process of ideation to transform the function and program of a building. This method can be quite "surgical" as the intricacies of a building are completely altered. Though, it can also be an opportunity for an architect to generate new ideas for what a space should look like.

The MIT Metropolitan Warehouse in Massachusetts (figure 1) is an example of how such a building can be engaging in a city. In 1894, Frederic Pope designed a large industrial building for storage, to "protect the treasures of Boston's wealthiest families" ("MIT Metropolitan Warehouse", 2018). In 2018, the firm Diller Scofidio + Renfro, repurposed it into a centre for MIT's School of Architecture. It was a challenge because the scale of the building was very large and it was just built to store objects ("MIT Metropolitan Warehouse", 2018). The comfortable attributes of a design studio – natural light, easy circulation, clean air and inspiring workspaces, were not even conceivable in the original building.

New design strategies had to be used given the complexity of the transformation. The firm took inspiration from the artwork of Gordon Matta-Clark – whose installation projects often featured the reconstructing of space. He performed experiments on how architecture could be cut, sliced, removed, displaced and changed completely, in an almost illusionary way (Walker, 2005). This artistic form of changing the ways that a building operates was inspiring to the renovators of the warehouse, leading to a more exposed style. The building's more discrete design successfully combines the past and the present – maintaining both the heavy brick and new glass facade. It also blends seamlessly with the existing neighbourhood, while also asserting itself as a hub for architectural study. Here, it is clear that adaptive reuse is a good way to appreciate both the historical significance of a building and revitalise it into a new centre for people in the community to use. With this project, adaptive reuse is significant because it brings about a project that could never be created in one continuous method. The timeline of architects from the past and present are interwoven to appreciate multiple styles and methods of construction. It highlights the way that designing with respect to the existing context can be an interesting opportunity.

However, in the 1900s, modernism emerged as a new architectural style that was desensitised to context and culture. Smooth white surfaces, flushed window trim and even geometries have been used in building construction – but these stylistic choices do not express specific attributes of the place they are in.

Figure 1: Rendering of the MIT Metropolitan Warehouse
Source: "MIT Metropolitan Warehouse." 2018. DS+R. 2018. https://dsrny.com/project/mit-metropolitan-warehouse

Though this occurred throughout the western world, Spain was spared due to the dictatorship of Francisco Franco. During the rule of Franco, the country did not make many drastic aesthetic changes, and they were not influenced by the new building techniques discovered by other parts of the world. Therefore, the country observed the successes and failures of other urban planning methods from other countries. Hence, in Spain, they were more inclined to graft onto existing buildings and expand their cities from their existing forms. Spain has a history of adaptive reuse as it has been under various ethnic groups and leadership styles. For example, the Great Mosque of Cordoba has alternated between its use as a mosque and a church. It has basically been an adaptive reuse project for nearly 1300 years, and it still stands today as a popular tourist destination (Craun 2012).

When planning, the Spanish wanted to change the organisation of the city in a movement known as *La Transicion*. They established local architectural organisations called *colegios*, which worked together to renovate different parts of the country. Here, they considered parts of modernist thinking but still wanted to maintain strong cultural roots within their architecture. Much of the changes had the goal "of tending all the city's wounds, whether large or small, such as urban voids, dysfunctional areas, and inadequate public spaces and services" (Craun, 2012). Here, Spain prioritised making their existing public grounds enjoyable to inhabit, rather than quickly building new structures to join the rest of the world in their modernist sprawl. Even in 1992 when they hosted the Olympics in Barcelona, they adaptively reused the new buildings for housing – even going as far as to ask the nearby community members if they were okay to continue construction (figure 2).

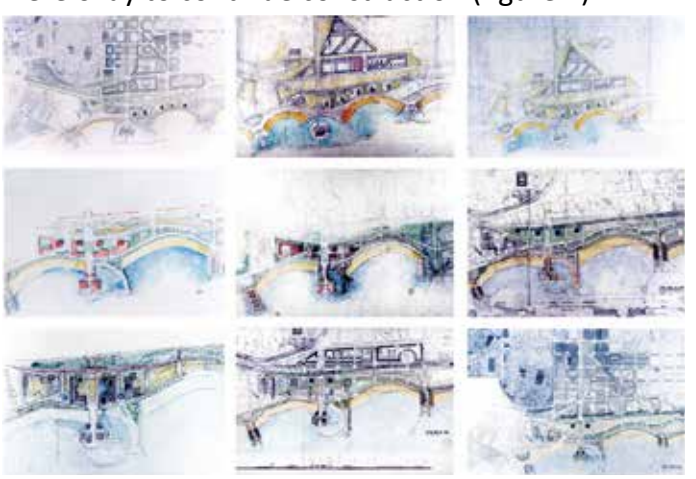

Figure 2: Plans for the 1992 Olympics in Barcelona
(Source: MGM Architects. 1992. Preliminary Sketches - Barcelona Olympic Village Port https://www.world-architects.com/en/mbm-arquitectes-barcelona/project/olympic-village-port-and-litoral-park#image-3)

In this interesting case of Spain, great technological advancements did not need to be made to keep the beauty of the city because they used the same building styles of the past to continue their topographical legacy. The people who construct there simply use similar methods as they did in the past and the walkability, transportation and overall structure of the city was maintained. By appreciating their heritage, people who live in Spain can see history reflected in the present.

Adaptive reuse has certainly made a case for itself on the scale of corporate architecture and heritage sites, but it can also be seen in some smaller campaigns. In Venezuela, Centro Financiero Confinanzas, now known as Torre David (figure 3), is an example of adaptive reuse by a grassroots initiative. The tower was initially built to be a banking complex, but during the 1994 Venezuelan banking crisis, the project was abandoned. This left a 45-storey tower with an extensive framework completed. The tower was left slightly unfinished and completely unoccupied, but remained as a symbol for the hopeful economic improvement that Venezuelans were anticipating. In 2007, a group of people who had been evicted saw an opportunity in the abandoned tower (Brillembourg et al. 2013). They set up their shelters and eventually established a new community there.

Figure 3: Torre David by Daniel Shwartz
(Source: Shwartz, Daniel. 2012. Torre David - the World's Largest Squat. Urban Think Tank. https://www.danielschwartz.co/torre-david)

This was an interesting phenomenon as it questions – what is really needed for a community to thrive? Given that the people had a reasonable amount of space for their shelter, an active community, and many resources very close to their homes, the people enjoyed the fruits of society. In this scenario, the people had limited resources and they created an inspiring societal structure, just by repurposing the building that they saw. Ultimately, adaptive reuse presents itself as a good solution during economic distress.

With gentrification on the rise and affordable housing at a perilous position all around the world – this adaptive reuse of the Centro Financiero Confinanzas is a prime example of how individuals can create communities in the midst of an economic crisis. This challenges the idea that housing must present itself in a certain way or become established on the outskirts of a city. Additionally, with architecture being such an expensive and exclusive field, this tower also reveals how people can create a successful neighbourhood through their own agency. After all, the people living in a space know more about their own preferences than a further removed architect creating a project as a commission for a business or government. The root of architecture traces back to the people occupying it, and here, it is striking to see people becoming innovative and taking initiative. Societies thrive more when their buildings are functional, in proximity and are beautiful. The looming environmental problems of the world, economic concerns and breaks in societal structures are not as daunting when given the solution of adaptive reuse.

Ultimately, the landscape of tomorrow may look like the landscape of today, if adaptive reuse continues. As seen through these case studies, adaptive reuse is a way to skew buildings towards new facilities. Even as people need different organisations of space, the unique characteristics of their community are maintained without disrupting the flow of business and greatly harming the environment. Adaptive reuse shows how people can become craftier with their architecture problem-solving on a corporate level – as can be seen in the project by Diller Scofidio + Renfro, as a country-wide initiative – as seen in Spain, and at the smaller scale of a family unit, and as seen in Torre David. Regardless, these projects are evidence of people taking charge of communities that they love and respect, to create architecture that will last.

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SECOND PRIZE

Rebuilding Somalia – How Architecture is leading the Revival after War

By Matthew Batista

Since the 1980s, Somalia has been devastated by nearly continuous warfare, which has had a profound and lasting impact on the country's social, political and economic stability. The overthrow of President Maxamed Siyaad Barre and the subsequent collapse of the central government in 1991 created a power vacuum that plunged the nation into chaos (Reuters, 2007). This led to widespread clan-based violence, with various factions, militias and warlords battling for control over key territories and valuable resources, further entrenching the country in a prolonged crisis. As a result, Somalia currently struggles with a lack of basic infrastructure, lawlessness and a weakened social fabric, making recovery seem nearly impossible (Slater, 2017).

Despite these immense challenges, new movements in architecture are emerging, playing a vital role in the country's rebuilding process. Architects, urban planners and local communities are working together to restore and modernise cities, focusing on creating sustainable and functional spaces that reflect Somalia's cultural heritage while also addressing the practical needs of a war-torn society. "I am confident that the proliferation of public space in this country is a major step towards its peace-building efforts and a means to heal the scars of its turbulent past," says Omar Degan (Latief, 2019).

Degan is an Italian-born Somali architect whose parents fled their motherland amidst the civil war (Dahir, 2021). A graduate of the Politecnico di Torino and the Chinese University of Hong Kong, his architectural philosophy is rooted in celebrating cultural diversity through architectural design, emphasising this approach through architecture and design. As Degan describes it, "You learn about heritage and preservation of cultural identity. This sensibility, from my point of view, is what makes a difference" (Max, 2022). Degan is the founder and the current principal of the Do Architecture Group, based in the capital of Somalia, Mogadishu, with offices in Italy and the United States, in which their objective is to "advocate for an architecture that promotes cultural diversity, peace, justice and human dignity" (*People — DO Architecture Group*, n.d.).

Somali architecture can be defined as a unique blend of traditional and modern influences, shaped by the country's rich history, diverse cultures and varied geographical landscape (figure 4). It incorporates elements from Islamic, Arab and colonial designs, alongside notable Italian influences during its colonisation of the country between 1889–1936, creating a unique architectural identity that reflects the nation's cultural heritage and evolving history, which can be seen in the works of Degan and his firm.

Figure 4: Render of Mosque Baidoa's main courtyard
Source: Design Indaba

Some of his works include the Newt and Pat Tarble Public Library, a project in collaboration with the Give to Learn to Grow Foundation. The library is set to open by the end of 2025 for the city of Laascaanood, offering quality education and opportunities for the community at large (*The Newt and Pat Tarble Public Library — Give to Learn to Grow*, n.d.). In 2022, his firm completed the Salsabii, a multi-functional site originally intended to become a supermarket (figure 5). It now serves the people of Mogadishu as a leisure and cultural space. The design of this project "takes inspiration from the rich cultural identity and heritage of Somalia" Degan explains. Its design is simple and crisp, following the architectural principles of Islam, with a span of two floors for its café and restaurant. This project is rich in symbolism, blending boutique style with refinement. Degan also incorporates soft furnishings made from fabrics significant to Somali culture, set against clean white walls, ceilings and built-in furniture. Driven by his desire to support local arts and the challenge of sourcing certain materials in Mogadishu, such as imported woods, Degan collaborated with local artisans to bring his design to life, using a light metal structure and cement boards (Stathaki & Photography, 2022).

Figure 5: The exterior of Degan's Salsabiil
Source: Omar Degan

Degan's work is not the only significant contribution to the redevelopment of war-torn Somalia. Yusuf Shegow, a graduate of the University of Manchester, has also made remarkable strides in this effort. Shegow is the founder of Somali Architecture, an innovative project dedicated to digitally recreating the buildings and monuments of Mogadishu from its pre-war era. Like Degan, Shegow's family had also fled the country due to war. His grandfather shared stories with him from his time working at the Jubba Hotel, where diplomats and dignitaries stayed during visits to the country in the 1970s. Back then, Somalia was referred to as the "Switzerland of Africa" (Buranyi, 2020). His interest in the redevelopment came from his first visit to the country in 2013 after almost ten years. As he walked around Mogadishu with his father, he was struck by the variety of styles and influences among the ruined, war-damaged buildings. This made him question: "What used to be here?" Having grown up in Kenya and the United Kingdom, the trip reignited his fascination with his birthplace (Doezema, 2018). Through this digital restoration, Shegow aims to present a hopeful vision of the city's past. His work not only highlights the architectural beauty and heritage of Mogadishu but also serves as a powerful tool for preserving the city's history, fostering pride among Somalis, and inspiring future generations to rebuild and rejuvenate their homeland (*Somali Architecture*, n.d.).

"We give them a glimpse of the history of Somalia, and then we focus on Mogadishu because it had a lot of architectural style," he explained in an interview with CBC News. "We just show all these buildings, reconstructed in 3D [...] how they used to look like, what they can look like right now, and how they can be the foundation of the future of Somalia" (*Reconstructing Mogadishu: Using 3D Models to Preserve Somalia's Pre-war Beauty | CBC Radio*, 2018). The team has created around fifteen 3D models, including the Arba'a Rukun Mosque, the National Theater of Somalia and the Mogadishu Cathedral, the latter of which the group proposes to redevelop the site into a public garden and war museum (Pavka, 2018). Designed by Italian architect Vandone di Cortemilia in 1928, the cathedral was largely destroyed during the Civil War. While the tower bells and roof are completely gone, the walls and part of the west façade remain. Transforming the cathedral into a war museum would serve as both an act of preservation and progress, essential for rebuilding a shattered society, both physically and mentally, after decades of conflict (Dahir & Dahir, 2022). The project does not have the benefit of 3D cameras, as much of the damage in Mogadishu has

already been done. With much of the city's historic architecture and infrastructure either damaged or destroyed due to years of conflict, Shegow and his team rely heavily on archival photographs and crowd sourced images from locals, many of whom have lived through the city's changes, without any digital records. In 2018, Shegow, in collaboration with Madina Scacchi, Iman Mohamed and Ahmed Mussa, participated in the London Design Biennale, showcasing their installation of the "Refugees Pavilion." The exhibit explored the impact of the civil war on architectural heritage, guiding visitors through images and video projections that depicted the devastation. These visuals not only highlighted the physical transformation of the country's landscape but also conveyed the profound human toll that accompanied this destruction (Scacchi, 2018). Scacchi, who, like Degan, is Italian-Somali and he explains that it is "very important to know it's your history. Start from there and move forward for the future […] Not everything from the past is perfect, but history is what can teach us to move forward in a more conscious way."

However, it is important to acknowledge that there are currently several significant challenges impeding the overall growth and development of the country. A key issue is the limited availability of local resources, which forces developers to rely heavily on imported materials such as cement, steel and wood. For example, in Mogadishu, there's a demand for new buildings, but the cost of shipping materials from countries such as Kenya and Ethiopia has resulted in high construction costs, making building projects more expensive and often out of reach for many developers (ICED Facility, 2019). The political instability itself is another major issue, as ongoing security concerns in certain regions make it difficult for developers to operate efficiently. Infrastructure development is often slowed by these security challenges, as contractors face threats to their safety, which disrupts the supply of materials and the progress of construction work (Laurens, 2024). Additionally, the absence of a stable regulatory framework and the challenges of financing large-scale projects further complicate the situation. Despite these obstacles, some local architects and builders are working to overcome these challenges by using innovative, cost-effective solutions, such as locally sourced materials and traditional construction techniques, to reduce dependency on imports and contribute to the country's rebuilding efforts (Jibril & Shaban, 2021).

But like all else, these issues ultimately come down to politics. Since his election in 2022, President Xasan Sheekh Maxamuud's objectives for Somalia have focused on improving security, diversifying the economy and boosting regional trade and investments (Dalmar, 2023). However, political instability and socio-economic issues still plague the nation, which includes around half of the population unemployed, a vast portion suffering from illiteracy, and a low life expectancy at birth (United Nations High Commissioner for Refugees (UNHCR) et al., 2005).

In addition, the country has faced several natural disasters in recent years. From 2021 to 2023, Somalia experienced a severe drought (United Nations High Commissioner for Refugees (UNHCR) et al., 2005), affecting over 80% of the population and killing over 3.5 million livestock (Jazeera, 2021). Torrential downpours in October 2023 eventually led to severe flooding, impacting approximately 2.48 million people. The disaster displaced 1.2 million individuals and resulted in the deaths of more than 100 Somalis (Center for Preventive Action, 2024).

As architects and designers work to revive Somalia after years of conflict, their efforts extend far beyond the rebuilding of physical infrastructure. These professionals are deeply engaged in restoring the nation's cultural identity and heritage, which have been severely impacted by decades of war and instability. In a country where many historical landmarks, traditions and cultural symbols have been lost or damaged, although it might seem that there's still a long way to go, architecture plays a crucial role in preserving and celebrating the unique Somali heritage. As Degan concludes, "We must be proud of who we are, and where we come from, and I believe that architecture is the representation of this cultural identity. Architecture can be a symbol of a renaissance and a new modern era" (Munu, 2021).

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THIRD PRIZE

Emerging Landscapes and Urban Transitions

Santo Domingo's Path Towards a Sustainable Future?

By Dahirandy Pérez Cena

"Thinking through the differences between narratives driven by a sense of crisis and narratives driven by a sense of change, they argue for the creation of future imaginaries based on a moral ecology of interdependence, creative adaptation and resilience through practical knowledge." (Thornton & Thornton, 2015, p. 66).

In the constant theoretical and practical evolution of landscapes, which in the past were perceived as static and individualistic in relation to the built environment, the concept of emerging landscapes arises. This concept transcends apparent contradictions to offer interdisciplinary responses to the greatest challenge of our century: interconnecting the natural, human, built and technological realms in a synchronised dance of transformations toward a sustainable future.

This essay will examine the city of Santo Domingo as a fascinating case study in the Caribbean, reflecting on whether urban transitions are a utopia and a dead-end of outdated planning patterns or a negotiation arena for social, cultural, environmental, technological, urban, architectural, and heritage identity dialogues.

Tradition: Positive or negative, easy or difficult to face across disciplines?

I have realised that, regardless of the context, discussing breaking traditions is controversial because they are often assumed to yield guaranteed results, causing us to miss opportunities for improvement. This is a tangible reality in the large-scale construction sector.

Santo Domingo, the capital and most populous city of the Dominican Republic, like many countries in the Global South, is constantly evolving as a living organism that has grown at an accelerated pace. Architecture, as De Piccoli Córdoba (2010) explains, "it establishes patterns resulting in a repertoire of extremely rich visual language manifested through time and space" (p. 150). It has witnessed the imposing colonial walls that still stand and blend with modern buildings. However, this beautiful transition is not always harmonious due to the many heritage and conservation regulations that constrain those who wish to innovate, often leading to the absolute deterioration and demolition of many historical relics.

In recent times, however, the landscape has shifted towards heritage-driven regeneration, with areas like the Colonial Zone becoming tourist, cultural, and community hubs undergoing constant maintenance.

Kaal (2011, as cited in Guttormsen et al., 2023), in his article "A Conceptual History of Livability", states that a socially sustainable city can be defined as a "livable city," and "by including the social use of heritage in the blending of historically and renewed urban environments, we can support factors such as identity, belonging, happiness and health for all citizens. Thus, it can be argued that community

involvement and participatory engagement in urban planning allow for negotiation and dialogue among the various groups that have an interest in a place leading to the development of heritage-led regeneration projects" (p. 2).

The second transition to highlight pertains to urbanism, which began long ago with the blurring of the line between urban and rural spaces during the Industrial Revolution in the 18th century and later with the First Agricultural Revolution. However, migration patterns have evolved to be intercity.

Santo Domingo exhibits an uncontrolled and often chaotic urban sprawl pattern, with a population of 1.029 million (2022 Census) and a surface area of 2,770 km², and a population density of 866.75 inhabitants/km².

In this context, evolving urban patterns challenge traditional norms by fragmenting the planned city model. In Santo Domingo, horizontal expansion towards the outskirts combines informal settlements and formal developments. Meanwhile, the urban centre grows vertically, marked by luxury, exclusivity, inequality, and concrete. Despite this, small marginalised neighbourhoods exist unevenly within the centre (as seen in figure 6).

This contrast reflects tensions between growth and sustainability, accentuating structural issues such as social inequality and lack of spatial integration. At first glance, this seems problematic because as Pottinger-Glass, Archer, and Asvanon (2023) state, "a certain degree of density is necessary for sustainability" (p. 18, [own translation], leading to a shift from traditional urban planning focused on zoning and spatial order to adapt to unpredictable growth—a challenge not unique to this Caribbean nation.

In 2012, UN Habitat highlighted a migration trend between cities and from metropolises to secondary cities, which "could lead to a decrease in the centrality of some major urban areas and shifts in urban hierarchies, especially due to the growth and new roles of intermediate cities".

In Santo Domingo, fragmentation is being addressed by combining large-scale plans with local plans that cater to specific area needs. Mobility has also improved to curb carbon emissions, a complex issue due to the city's near-zero pedestrian and sustainable mobility concept. However, an integrated transport system is gradually taking shape with a metro, cable car, and buses in a second phase. Despite resistance from informal transport operators, this transition has eased traffic congestion and reduced social and spatial segregation, improving accessibility for citizens in isolated neighbourhoods and creating urban networks in areas like Los Alcarrizos. Although this area is just 40 minutes from downtown, traffic congestion extends travel times to up to 2.5 hours.

Figure 6: Marginalised neighbourhoods in central Santo Domingo.
Source: https://www.elcaribe.com.do/panorama/pais/barrios-marginados-de-la-capital-contrastan-con

This scenario introduces the concept of de-metropolitanisation, where secondary cities take on a leading role, challenging their perception as satellites and strengthening their autonomy. This phenomenon is closely linked to models like the "15-minute city," "the contemporary synthesis of the renaissance "ideal city", where the classical "human measure" has now been interpreted, far away from a geometrical perspective, in the framework of current health and environmental risks, these models prioritise proximity to essential services, foster more cohesive communities, and reduce carbon emissions and excessive urban land use.

De-metropolitanisation, by decentralising urban dynamics, will enable inclusive and sustainable future landscapes, integrating green spaces, efficient infrastructure and mixed uses reflecting current needs. Architecture and urban design play a key role in this transition, promoting functional density, urban reforestation and sustainable technologies—a topic where we lag despite the urgency of climate change. This model prioritises environmental sustainability and balances urban development with collective well-being, laying the groundwork for resilient, human-centred cities ready for future challenges.

Santo Domingo / Climate Change / Overbuilt, Under-Natured

Discussing environmental sustainability and resilience in Santo Domingo goes beyond a global challenge; it addresses an imminent reality for our island nation. Our geographic location places us directly in the hurricane's path of climate change, with rising sea levels, ecosystem degradation, and vulnerability to extreme weather events like hurricanes due to Caribbean trade winds historically causing devastating disasters. Our recovery capacity has been slow, hindered by infrastructure deficiencies and urban planning shortcomings.

Throughout history, climate change has been closely tied to economic evolution. Industrialisation, reliance on fossil fuels for economic activities, and urban expansion have accelerated this phenomenon. Considering the scenario outlined earlier, our actions as architectural professionals must be cautious to develop and grow without harming the planet.

One of today's most critical problems is the lack of green spaces and overconcentration of buildings, leading not only to a visually rustic, stifling, and unfriendly landscape but also to a phenomenon known as the "urban heat island". This creates unsustainable city environments where high temperatures and air and water pollution severely impact residents' health. Despite regulations on paper, transitioning to a greener and more resilient urban model has been extremely slow, largely due to corruption and a lack of political will.

An Opportunity

Climate change should not only be seen as a challenge but also as an opportunity to rethink and transform urban landscapes. Cities must adapt, and urbanism is simultaneously creating new neighbourhoods and communities that demand designs integrating these developments with natural surroundings without depleting resources or harming the environment.

Architectural design, having been a witness and executor of the past, is also an executor of the future. If transitions are carried out correctly and in consensus with all societal actors, the future landscape in Santo Domingo and at a global level, will be sustainable.

The landscape is the lens through which we have understood cities, their diversity, and their complexity. We have left behind the delineation of urban and rural, and the natural and built environments are no longer seen as separate but as elements interacting dynamically.

Taking as a starting point Iwaniec et al. (2020), transformative scenarios "apply backcasting approaches by starting from sustainability visioning, followed by the development of transition pathways from the envisioned future state to the current state".

Transformative scenarios propose a radical and normative approach that challenges the status quo to redesign social, ecological, and technological systems, breaking away from traditional practices. This model employs backcasting to develop transition pathways enabling the achievement of the desired future from the present. Imagining more equitable, resilient and sustainable cities, transformative scenarios drive structural changes in urban planning, energy, mobility, and resource management paradigms.

In the context of future landscapes, this means integrating advanced technologies with nature-based design principles, efficient drainage systems and elevated buildings essential to protect people and infrastructure from floods and natural disasters.

Urban reforestation and the reuse of abandoned industrial spaces for vertical farming are

strategic solutions to address vacant spaces and deindustrialisation in cities. These initiatives rehabilitate contaminated lands, create green areas, and reconnect people with their environment, fostering active environmental management. Additionally, these practices promote local food production, benefiting nearby communities.

Architecture can also create ecological corridors connecting natural areas within cities and linking them to satellite cities, regardless of social class, alongside emission zones. The future landscape will be hybrid: a blend of technological and ecological infrastructure where the boundaries between built and natural environments blur, generating a more harmonious and functional setting not only for humans but also for the planet's sustainability.

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STUDENT WORK

Role of Shading Devices in Enhancing Thermal and Visual Comfort of an Indoor Workspace

By Noynika Shah and Ar. Priya Arora

1. Introduction

Shading devices, as an integral part of architectural design, offer solutions to mitigate solar radiation while increasing the indoor environmental quality. Semi-arid climates present unique challenges to maintaining indoor comfort through their extreme temperatures and very high solar exposure. Therefore, shading devices are indispensable for moderating the thermal conditions, maximising daylight penetration and optimising visual comfort.

1.1 Aim and hypothesis

The aim of the study is to evaluate the effectiveness of different combinations of shading device materials and design configurations on improving thermal and visual comfort in indoor workspaces within semi-arid climate. It is hypothesised that the material and design of shading devices have a significant impact on thermal and visual comfort in indoor workspaces within semi-arid climates, with optimised combinations expected to reduce heat gain and glare while enhancing daylight quality.

1.2 Research objectives and limitations

The objectives formulated to achieve the aim of this study are as follows.

- To study the role, types, design and materials of shading devices
- To understand the influence of shading devices on thermal and visual comfort in indoor workspaces in a semi-arid climate
- To analyse and compare the performance and efficiency of different shading devices through case studies in semi-arid regions, focusing on their impact on indoor thermal and visual conditions
- To propose optimised shading device solutions tailored to indoor workspace in semi-arid climate

The study is limited to semi-arid climates, where extreme temperatures and high solar radiation are prevalent. The study will also be limited to buildings that include institutional, workshop and commercial spaces.

2. Literature review

Based on previous research findings, this review explains the objectives of the study and highlight the effects the shading device configurations will have on thermal regulation and daylight optimisation.

2.1 Role and importance of shading devices

Shading devices are the key architectural elements that regulate the solar radiation entering a building. They control glare and indoor heat gain through the modulation of sunlight exposure to promote thermal and visual comfort. The shading device improves energy efficiency by minimising artificial cooling and artificial light dependencies. Consequently, their design must be balanced among shading effect, aesthetics and functionality in order for them to perform effectively (Figure 1).

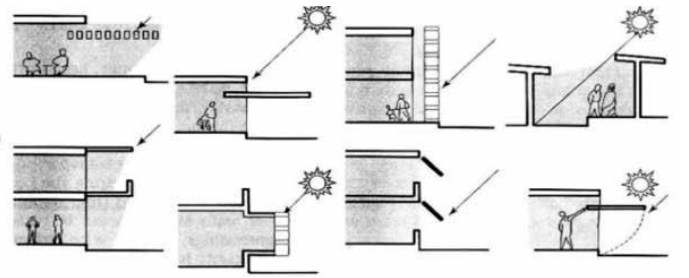


Figure 1: Different shading mass projected by different shading devices
Source: www.archdaily.com

2.2 Types and materials of shading devices

Different types of shading devices can be classified as fixed and dynamic. Fixed shading devices such as overhangs, awnings and louvers are static and thus apply uniform shade to a space based on predetermined solar angles. Dynamic shading devices such as motorised blinds or photochromic glass respond to changing environmental conditions. Materials range from metal, wood and fabric to glass and all induce varied benefits depending on resistance to wear, heat or light diffusion. Advanced composite materials such as fibre-reinforced polymer that exhibit a combination of advantages of number of materials thus provide superior strength than the ordinary (Figure 2).

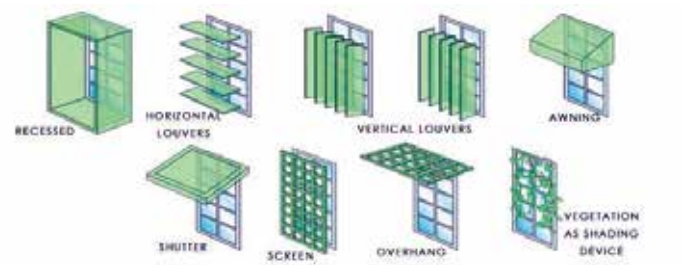


Figure 2: Different types of shading devices
Source: Case Studies, NZEB India

2.2.1 Fixed shading devices

Fixed shading devices are static structures designed for passive control of solar energy. Examples include canopies, pergolas and fins. They are cheap and demand little maintenance. However, because they cannot be adjusted to accommodate changing sun angles, they are less flexible than dynamic solutions. Durable for their aesthetic value, they usually take concrete, metal or wood in their making. Fixed shading is most effective in preventing incident sunlight for south-facing windows in regions experiencing high solar glare by blocking direct sunlight while allowing diffused light (Figure 3).

2.2.2 Dynamic shading devices

Dynamic shading devices are responsive systems, changing according to environmental conditions, which provide a greater control of light and heat.

Figure 3: Different types of fixed shading devices in different materials
Source: Kamal, 2010

Examples include retractable awnings, motorised blinds and electro chromic glass. These systems are advocated to be integrated with energy management technologies for optimal performance. These materials are smart glass, thermos-chromic coatings and shape memory alloys, which make dynamic shading able to modify in transmittance or inclination as a method to control heat conduction and contribute more to comfort while preventing energy losses (Figure 4).

Figure 4: Different types of dynamic shading devices in different materials
Source: Al-Yasiri & Szabó, 2021

2.3 Impact of shading devices on thermal and visual comfort in Semi-Arid climates

Shading devices play an important role in achieving comfort through regulated visual and thermal conditions indoors. By controlling solar gain, they provide load reduction, thus rendering occupant comfort within the enclosure. Visual comfort comes through glare reduction and balanced daylight distributions. In semi-arid climates, proper direction and control in the use of shading devices should ensure sustainable buildings by rendering energy-efficient conditions together with occupant comfort.

2.3.1 Thermal comfort

Thermal comfort is a crucial element of indoor environmental quality and signifies the state in which individuals feel comfortable with their surroundings. Achieving thermal comfort requires finding the right balance between environmental and personal factors to create a stable and comfortable indoor climate. In semi-arid regions, like certain areas of Rajasthan, thermal comfort becomes especially crucial due to the intense solar radiation and significant temperature fluctuations throughout the day.

Shading devices, which are architectural elements, play a crucial role in regulating indoor temperatures. By minimising direct solar heat gain, these devices assist in controlling heat entry, reducing the cooling load and ensuring a pleasant thermal environment within buildings.

2.3.2 Factors that influence thermal comfort

- Air temperature: The ambient temperature, which is the temperature of the air around us, is the most significant factor influencing thermal comfort and how we feel.
- Humidity: The level of moisture in the air impacts the body's capacity to regulate its temperature through sweating.
- Air velocity: The circulation of air is crucial in dissipating heat from the human body. When the air moves faster, it helps to remove heat from our bodies, making hot temperatures feel more tolerable.
- Solar gain: Solar gain is the heat energy that enters a building through sunlight, whether it comes directly through windows or is transferred through conduction. While some passive solar gain can be advantageous during winter, uncontrolled exposure during summer requires the use of shading devices to avoid overheating and discomfort.

2.3.3 Parameters and their effects on thermal comfort

Thermal comfort is influenced by factors such as the Solar Heat Gain Coefficient (SHGC), which determines the amount of solar radiation entering the space and the U-value, which reflects the thermal insulation properties of materials. Shading angles are crucial in blocking direct sun exposure, while the window-to-wall ratio directly impacts heat gain and indoor temperature balance.

2.3.4 Visual comfort

Visual comfort is the term used to describe the ease with which individuals can perform visual tasks without experiencing discomfort, strain or distraction. The balance between natural and artificial lighting is crucial to ensure sufficient illumination without causing issues such as glare or extreme contrast. In design terms, this means carefully considering the placement of shading devices, the direction of windows, the reflectivity of surfaces and the choice of materials to create a visually appealing and comfortable space.

2.3.5 Factors affecting visual comfort

- Illuminance levels: This demonstrates the quantity of light that reaches a surface and influences the level of illumination required for various activities.
- Glare: Glare occurs when there is an excessive amount of brightness or a significant contrast between light and dark areas, leading to visual discomfort. This can arise from direct sunlight, reflective surfaces or improperly placed artificial lights.
- Daylight penetration: The amount and intensity of natural light that enters and spreads within a space greatly impact the overall lighting quality.
- Colour temperature: The appearance of light ranging from warm to cool, which impacts visual ambiance and alertness.

2.3.6 Parameters and their effects on visual comfort

Visual comfort depends on visible light transmittance, which controls daylight entry and glare control measures that reduce visual strain. Daylight availability and surface reflectance further influence light distribution and ambient brightness within a space.

There also several studies that highlight the performance of shading devices in hot climates. Alwetaishi et al (2021) emphasises using horizontal overhangs for south-facing windows and vertical fins for east-west facades to reduce heat gain in school buildings. Tavares and Silva (2008) illustrates how natural daylight integration can reduce dependency on artificial lighting, improving visual comfort. Dabaj et al (2022) assesses a reading room with four-sided openings using simulations. It concludes that properly oriented shading improves daylight distribution and minimises glare.

3. Methodology

This research employs a combination of field measurements and simulations to assess the influence of shading devices on thermal and visual comfort in semi-arid regions. Tools such as Energy Plus, Design Builder and Velux simulate real-life scenarios, while case studies provide valuable context and examples.

3.1 Data collection and simulations

Research was carried out on various buildings, each with different orientations and shading devices (louvers, blinds, overhangs). A 5-in-1 meter (device) measured temperature, humidity, air velocity and

light levels from 7:00 a.m. to 7:00 p.m. in all four directions. Survey of residents revealed contentment with comforts. Simulation tools utilised real-world data to evaluate shading effects and forecast thermal and visual outcomes. This method allowed for immediate feedback and the ability to assess different scenarios for improving comfort levels.

3.2 Survey data inferences

The survey highlights that fixed external shading devices are most effective for thermal comfort, while automated or movable shading devices are preferred for managing visual comfort by balancing light and glare. Fixed shading systems excel in heat reduction, whereas automated solutions address glare control effectively. Challenges include operational difficulties with movable devices and maintenance issues with fixed systems. A combination of shading strategies is, thus, recommended to optimise both thermal and visual comfort.

3.3 Case Studies

A: Indira Paryavaran Bhavan, New Delhi

Indira Paryavaran Bhavan, New Delhi, is a net-zero energy building with GRIHA 5-Star and LEED Platinum certification. It demonstrates high performance with a U-Factor of 0.49 W/m²·K and UDI of 75% (Table 1), indicating excellent insulation and daylight use. Optimal window-to-wall ratio (33%) and shading angles (30°–45°) reduce heat gain while maintaining 450 Lux average indoor lighting and low glare (DGP 0.30), making it a key precedent for balanced daylight and thermal control (Figure 5).

Figure 5: Building envelope of Indira Paryavaran Bhavan with 12m large overhang roof
Source: Author

B: MNIT, Jaipur

MNIT, Jaipur, provides real-time data showing indoor temperatures 3–5°C lower than outdoor (Table 2) and illuminance levels peaking at 850 Lux. Simulation results (Table 3) confirm that façade-specific shading (e.g., on east, south and west sides) significantly improves indoor comfort throughout the day.

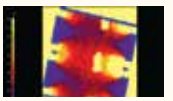
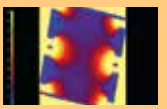
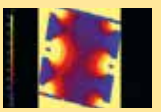
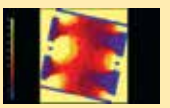
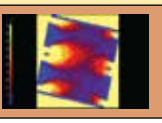
Table 1: Standards and actual values - Parameter have been calculated by formulas given in ECBC Guidelines and the NBC, 2016
Source: Author

Factor	Standards	Actual Values
Solar Heat Gain Coefficient (SHGC)	0.25 – 0.35	0.32
Shading Coefficient (SC)	0.30 – 0.40	0.32
U-Factor (W/m²·K)	2.0 – 2.5	0.49
Window-to-Wall Ratio (WWR)	30% - 40%	33%
Shading Mass	Moderate shading	
Shading Angle	30° - 45°	
Useful Daylight Index (UDI)	60% - 70%	75%
Visible Light Transmittance (VLT)	0.6 – 0.7	0.59
Daylighting Factor (DF)	2% - 5%	4%
Lux (Illuminance Level)	300 – 500 Lux	400 Lux
Average Indoor Illuminance	400 – 500 Lux	450 Lux
Reflectance (Interior Surfaces)	0.5 – 0.7	0.6
Glare (DGP – Daylight Glare Probability)	< 0.35 (comfort)	0.30

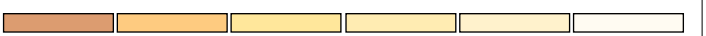
Table 2: Measured temperature data at site of MNIT of an Architectural studio
Source: Author

Time	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM
Indoor Temperature (°C)	26	28	28	27	26	24
Outdoor Temperature (°C)	30	33	33	31	30	30
Lux (Lx)	550	700	800	850	800	650

Table 3: MNIT architecture studio daylight simulation from 8 am to 6 pm and their impacts on thermal and visual comfort
Source: Author

Case No.	Time	Simulation Result	Impact
1.	8 A.M.		Shading devices block early morning sunlight on east-facing surfaces, reducing localised heat buildup.
2.	10 A.M.		Shading reduces heat absorption in east and southeast-facing walls, helping maintain cooler indoor conditions.
3.	12 P.M.		Shading devices reduce direct exposure on south-facing walls, minimising mid-day overheating.
4.	2 P.M.		Shading significantly reduces heat gain in west-facing walls, maintaining thermal comfort.
5.	4 P.M.		Shading helps accelerate cooling in west-facing areas, improving thermal comfort.
6.	6 P.M.		Shading ensures heat gain is minimal during the late afternoon, aiding quicker dissipation of residual heat.

COMFORT (LOW TO HIGH)



4. Study area with simulations: Raaga Textiles, Jaipur

Raaga Textiles is a mid-sized textile manufacturing facility located in Jaipur, Rajasthan - an area characterised by a hot semi-arid climate with high solar exposure and significant diurnal temperature variations. The building houses various craft-based functions such as block printing, stitching, storage and block-making, each with specific thermal and lighting needs (Figure 6). These spaces are oriented differently, exposing them to varying degrees of solar radiation and daylight conditions throughout the day.

Figure 6: Different activities being held at the Raaga Textiles - A) Stitching room B) Printing room C) Block making D) Warehouse and tagging room
Source: Author

As a representative example of a regional craft industry workspace, Raaga Textiles was chosen to analyse the effectiveness of passive design strategies, particularly shading devices, in improving indoor environmental quality. The study involves climate-based daylight and thermal simulations across all four orientations (south, north, east and west), using shading typologies like overhangs, louvers and vertical fins to optimise performance (Figure 7).

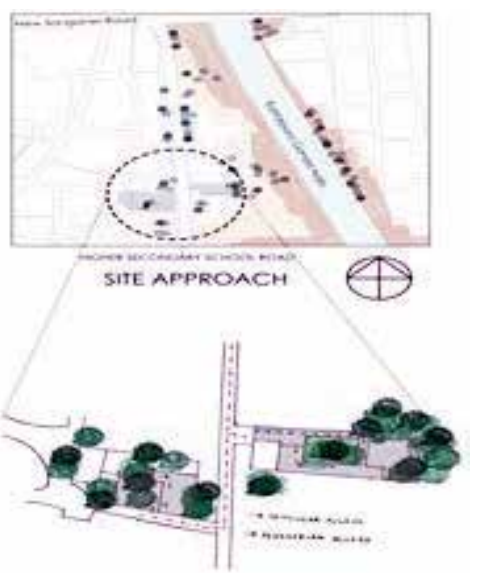


Figure 7: Plan of Raaga Textile
Source: Author

South: According to industry standards, the recommended temperature for printing rooms ranges between 20°C to 24°C with a relative humidity of 40% to 60% to prevent paper expansion and ink smudging (Table 4). For lighting, the standard Illuminance level is set at 500 to 1000 Lux, ensuring adequate visibility for fine detail work without glare or excessive brightness (Figure 8 and 9).

North: For temperature control, warehouses should maintain a range of 15°C to 25°C, depending on the nature of the stored materials, to prevent spoilage or degradation. The relative humidity should ideally be kept between 30% and 60% to safeguard against moisture-related damage. In terms of lighting, a minimum Illuminance level of 200 Lux is recommended for general storage areas, with up to 500 Lux for inspection or sorting zones.

East: For thermal conditions, stitching rooms should maintain a temperature range of 22°C to 26°C

Figure 8: Printing room which has fenestrations facing south direction: layout before and after adding fenestration - 12m x 7m
Source: Author

with relative humidity levels between 50% and 60% to support worker comfort and prevent fabric deformation. Adequate lighting is critical for detail-oriented tasks, with a recommended Illuminance level of 750 to 1000 Lux.

West: For thermal performance, block-making rooms should maintain a temperature range of 18°C to 24°C to ensure the stability of materials and

Table 4: Raaga Textiles South-facing printing room: simulation analysis on the basis of different cases
Source: Author

Case No.	Type of Shading Device	Daylight Factor	Temperature Difference (°C)	Daylight Analysis	Thermal Analysis
1.	None (Original Case)	3.5%	12°C	Moderate daylight; slightly below the optimal range	High cooling load; significant indoor-outdoor temperature difference
2.	0.5m Overhang (Original Case)	5.8%	10°C	High daylight; within the optimal range; at risk of glare	Improved thermal comfort; reduced cooling load
3.	1.5m Overhang with additional windows	2.0%	8°C	Low daylight; minimised light penetration	Excellent thermal comfort; lowest cooling load and minimal temperature difference
4.	0.5m Horizontal louvers with additional windows **(BEST CASE)**	4.2%	9°C	Balanced daylight; optimal visual comfort; controlled glare	Balanced thermal comfort; low cooling load and moderate temperature difference
5.	0.5m Horizontal louvers, fins and overhang with additional windows	6%	11°C	High daylight; exceeding the optimal range; leading to glare	Moderate thermal performance
6.	0.5m Overhang and fins with additional windows	6%	9°C	Moderate daylight; minimum glare	Higher cooling load; a moderate temperature difference

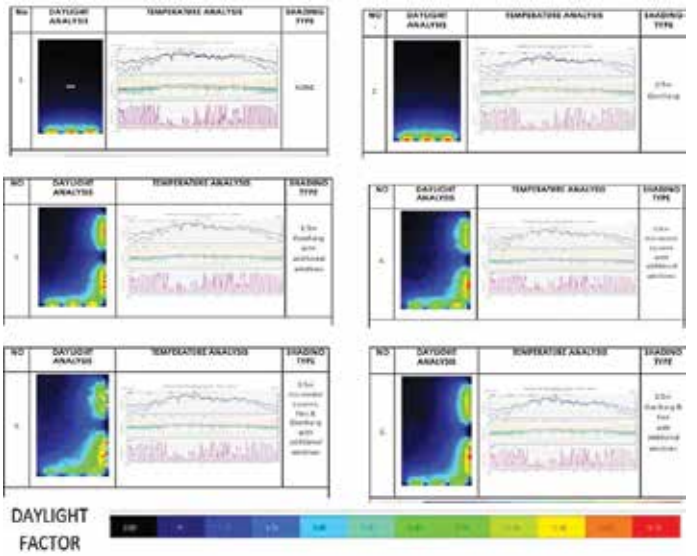


Figure 9: Simulations results of the South direction facing printing room with a daylight factor graph with 6 cases and different types of shading devices used.
Source: Author

comfort for workers during production. Relative humidity levels should ideally be kept between 40% and 60% to prevent material degradation. In terms of lighting, a minimum Illuminance level of 300 Lux is recommended for general tasks, with 500 to 750 Lux for precision work (Table 5).

5. Results and discussion

The simulation results show that orientation-specific shading devices significantly enhance thermal and visual comfort. South and west facades benefited most, with temperature reductions up to 8°C and cooling load reductions of 25 - 30%. Dynamic systems on east and south facade effectively reduced glare and solar heat gain. Fixed solutions like light shelves on the north ensured even daylight without overheating. The study confirms that passive, direction-responsive shading strategies are essential for energy efficiency and occupant comfort in climate-responsive design (Table 6).

Table 5: Raaga Textiles North, East and West facing: warehouse, stitching room and block making room – simulation analysis on the best case respectively
Source: Author

Case No.	Type of Shading Device for north, east and west	Daylight Factor	Temperature Difference (°C)	Daylight Analysis	Thermal Analysis
North	0.5m Horizontal louvers, fins and overhang	5%	6°C	Optimal daylight; even light distribution; no glare	Excellent thermal performance; lowest heating and cooling loads
East		5.2%	10°C	Balanced daylight; controlled glare	Moderate cooling and heating loads; minimised heat gain
West		5.2%	9°C	Reflective interiors and ventilation provide uniform light without glare	Stable thermal performance

Table 6: Raaga Textiles – results on the basis of the study and optimal solution for each direction
Source: By Author

Direction	Initial Temp (°C)	Optimised Temp (°C)	Daylight Factor (%)	Cooling Load Reduction (%)	Abstract Analysis Highlights
South	36	28	4.2	25	Dynamic systems reduce solar heat gain effectively; peak cooling loads reduced by 20-30%.
North	30	24	5.0	20	Fixed systems like light shelves ensure even daylight distribution while minimising heat gains.
East	34	26	5.2	25	Dynamic shading systems allow real-time adaptation to morning sun, reducing glare and enhancing lighting control.
West	37	29	4.8	30	Perforated screens combine shading with visual connectivity, optimising both thermal and visual comfort.

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STUDENT WORK

Exploring Energy Efficient Building Envelopes Using Phase Change Material

By Ar. Aditya Sanyal and Dr. Nirmita Mehrotra

1. Introduction

In the realm of sustainable architecture, the quest for energy-efficient building solutions is ever-evolving. The burgeoning field of research surrounding building envelopes is demonstrating the promising potential of integrating phase change biomaterials. These innovative materials offer a dynamic approach to thermal regulation, potentially revolutionising the way buildings manage energy consumption and enhance occupant comfort (Keshmiri, 2025). This article explores the cutting-edge research surrounding phase change biomaterials and their potential to transform building envelopes into adaptive systems that respond intelligently to environmental conditions. The research here includes a comparative software analysis conducted in ANSYS, a leading engineering simulation platform. The study models and analyses the thermal performance of Bio-PCM bricks and traditional paraffin-based PCM bricks under controlled conditions. The results from the steady-state and transient thermal simulations highlight the differences in thermal conductivity, heat flux behavior and temperature response between the two materials. These findings aim to determine which material offers superior insulation and adaptability for high-performance, energy-efficient building envelopes.

1.1 Aim and objectives

The primary aim of this research is to evaluate the effectiveness of phase change biomaterials (Bio-PCMs) in enhancing thermal performance and energy efficiency in residential building envelopes through adaptive design strategies, using ANSYS software for simulation-based analysis. Accordingly, the following objectives are formulated.

1. To investigate the thermal properties of selected bio-based PCMs (e.g., Bio-PCM and paraffin PCM) suitable for residential building applications in composite climate zones.
2. To design comparative simulation models of conventional and PCM-integrated building walls using ANSYS Fluent.
3. To analyse the impact of Bio-PCMs on indoor temperature regulation, heat flux and thermal storage using transient thermal simulations.
4. To assess the improvement in thermal comfort and potential energy savings achieved through the incorporation of Bio-PCMs.
5. To validate the simulation outcomes against existing literature and identify optimal PCM configurations for adaptive thermal envelope applications.

6. To propose sustainable building envelope design strategies that utilise phase change biomaterials to reduce HVAC dependency and improve energy performance in residential buildings.

2. Phase Change Materials

Natural phase change materials exhibit a reversible solid-liquid transition contingent upon temperature fluctuations. Their latent heat storage and release capabilities render them suitable for implementation within building envelopes, thereby augmenting thermal inertia and minimising dependence on traditional heating, ventilation and air conditioning systems. These materials are characterised by their renewability, biodegradability and capacity to enhance occupant thermal comfort, thus contributing to sustainable construction methodologies. Ongoing scholarly inquiry indicates that these materials are poised to assume a pivotal function in forthcoming advancements in environmentally responsible architectural design. (Airo'farulla, 2022). Bio-based phase change materials are innovative substances derived from natural sources, such as plant oils and waxes. Their unique ability to undergo reversible phase transitions (between solid and liquid states) in response to temperature changes is what sets them apart. The impressive ability of phase change materials to effectively store and release thermal energy makes them extremely useful for various applications, especially in sustainable building design (Younis, 2023). Synthetic compounds have been the origin of many phase change materials (PCMs), which have undergone extensive research over the past few decades. However, phase change materials have emerged as a sustainable alternative. These materials are derived from renewable resources, unlike synthetic PCMs, which may be derived from non-renewable petrochemical sources. This aligns with green building design principles and reduces environmental impact (Chen et al., 2024).

Table 1: List of different types of Bio-PCM according to building application, melting point (°C), and advantages
Source: Author

Sr. no.	Bio-Based PCM	Melting Point (°C)	Key Advantages	Typical Applications	Author(s) & Year
1.	Palm Oil	28–35	Renewable, non-toxic, biodegradable	Building envelopes, thermal storage	Sharma, Tyagi, Chen, & Buddhi, 2009
2.	Coconut Oil	23–27	Readily available, biodegradable	Passive heating/ cooling	Sharma et al., 2009
3.	Soybean Oil	20–30	Renewable, environmentally friendly	Thermal energy storage	Tyagi, Kaushik, Tyagi, & Akiyama, 2007
4.	Stearic Acid	55–70	Good thermal stability, non-corrosive	Thermal storage, composites	Zalba, Marin, Cabeza, & Mehling, 2003
5.	Capric Acid	31–33	High latent heat, bio-derived	Building materials, PCMs	Sharma et al., 2009
6.	Lauric Acid	43–45	Biodegradable, natural origin	Phase change applications	Sharma et al., 2009
7.	Beeswax	62–65	Natural, renewable, stable	Thermal storage	Abhat, 1983
8.	Bio-based Paraffin	20–60 (varies)	Sustainable alternative to petroleum	Thermal energy storage	Sharma et al., 2009
9.	Fatty Acid Esters	Variable	Renewable, biodegradable, tunable	Composite PCMs	Castell, Cabeza, Farid, & Mehling, 2010
10.	Carnauba Wax	82–86	Natural plant wax, biodegradable	High temp applications	Sharma et al., 2009

Phase change materials have a wide range of potential uses. These materials can be integrated into building elements like walls, ceilings and floors to create adaptive thermal envelopes, which have significant implications for building design. By strategically placing phase change materials within these architectural components, architects and engineers can control indoor temperatures, minimise temperature fluctuations and reduce reliance on mechanical heating and cooling systems (Aksamija, 2017). This improvement in occupant comfort also reduces energy consumption and lowers operational costs throughout the building's lifespan. In addition to their thermal properties, phase change materials offer other desirable characteristics. They are often biodegradable, non-toxic and pose minimal risk to human health and the environment. Furthermore, ongoing research in material science and engineering continues to expand the range of available materials, offering designers greater flexibility and customisation in meeting specific project requirements.

Phase change materials are essential for unlocking their full potential in various applications, particularly in the realm of sustainable building design (Kantaros,2024). Architects, engineers and researchers can develop innovative solutions that improve thermal comfort, lower energy consumption and support environmental sustainability by utilising the inherent properties of phase change materials. The increasing demand for sustainable building solutions has positioned phase-change materials as a key component in the future of architecture and construction. This will promote the development of buildings that are not only environmentally friendly but also adaptable and durable.

3. Methodology

This research employs a simulation-based approach using ANSYS Fluent to analyse and compare the thermal performance of Bio-based phase change materials (Bio-PCMs) and Paraffin-based PCMs in residential building envelopes. Initially, the thermophysical properties of both PCMs—such as thermal conductivity, specific heat, density, latent heat of fusion and melting point—were collected from validated sources. Two building envelope models were developed in ANSYS: one integrated with Bio-PCM (e.g., derived from fatty acids) and the other with Paraffin PCM. Each model replicates a typical wall assembly comprising plaster, insulation, a PCM layer (5–20 mm) and brick masonry. The composite climate of India (e.g., Delhi region) was selected for the thermal boundary conditions, simulating 24-hour transient temperature cycles. The enthalpy-porosity method was used to simulate the melting–solidification behavior of the PCMs. Key parameters, including internal wall surface temperature, heat flux and thermal lag were analysed to evaluate and compare energy efficiency and comfort performance. Simulation results help determine which material provides superior thermal regulation, reduced peak indoor temperatures and higher energy savings. This comparative analysis contributes to understanding the suitability of each PCM type for use in adaptive thermal envelopes in sustainable residential architecture.

4. Phenomenon of phase change material

Phase change materials (or PCMs) are materials that absorb and release large amounts of energy when they change phases, for example from solid to liquid or liquid to gas, to provide the stored energy for heating or cooling a system. In most cases, the change of matter happens between solid to liquid. PCMs have various applications due to their latent heat storage capabilities. These applications include thermal regulation in buildings, energy storage systems, waste heat recovery and temperature management in diverse areas. Specific examples encompass thermo-regulating fibers and smart textiles, thermal management of batteries and microelectronics, photovoltaic thermal (PV/T) systems, space and terrestrial thermal energy storage and greenhouse temperature control.

4.1 Types of Phase Change Materials

There are 3 types of phase change materials: Organic PCMs, Inorganic PCMs and Eutectic PCMs.

a. Organic phase change materials (PCM) are most commonly made of hydrocarbon-based substances. There are three subcategories: paraffin, fatty acids and Bio PCM.

- **Paraffin:** They are most commonly used in cooling systems because they can retain a lot of heat. This makes it excellent for storage of energy (Figure 1).
- **Fatty acids:** These PCMs are an environmentally friendly alternative. It is because they are usually destroyed naturally and can be rebuilt.
- **Bio PCM:** These are phase change materials that originate from renewable sources, such as plant-based materials or organic waste. Bio PCMs are an eco-friendly type of PCM, generally non-toxic and pose minimal health risks. They are recyclable and can be tailored to respond to specific human occupancy patterns within a

Figure 1: Sample of paraffin wax
Source: Kuta, M., et.al, 2016

building. They have potential to be integrated into various building elements like floors, roofs and concrete.

Some of the advantages and disadvantages of organic PCM are:

Advantages:

1. Can be recycled with other materials
2. Chemically stable
3. High latent heat capacity

Disadvantages:

1. Flammability
2. Low thermal conductivity in solid state
3. More expensive than other options

b. Inorganic PCMs: Salt hydrates or metals are commonly used in the fabrication of inorganic PCMs. These PCMs have superior thermal conductivity and are significantly more efficient in storing energy compared to organic PCMs.

- Salt hydrates: They are compounds that are comprised of salt and water. Salt hydrates are commonly used in high temperature applications ranging from 8 to 120°C.
- Metals: Though less popular, metallic PCMs are extraordinarily efficient in heat conduction but are costlier than the other alternatives.

Some advantages and disadvantages of inorganic PCMs are:

Advantages:

1. Availability at low cost
2. Low volume change
3. High thermal conductivity
4. Non-flammable
5. High capacity for latent heat storage

Disadvantages:

1. Corrosion
2. Super cooling
3. Lack of thermal stability
4. Prone to degradation
5. Chemical instability
6. Requires container and support

c. Eutectic PCMs: They combine two or more organic or inorganic PCMs. There are three types of Eutectic PCMs - Organic-organic PCM, Organic-Inorganic PCM and Inorganic-inorganic PCM.

Some advantages and disadvantages of eutectic PCMs are:

Advantages:

1. High volumetric thermal storage
2. Density
3. Sharp melting temperature

Disadvantages:

1. Strong Odor
2. Costly
3. Low total latent heat capacity

Paraffin waxes consist of hydrocarbon chains and exhibit melting points between 20°C and 60°C, making them suitable for a wide range of thermal applications. Fatty acids, derived from natural carboxylic acids, melt within a narrower range of 20°C to 50°C and are often favored for their biodegradability. In contrast, inorganic salt hydrates, composed of salts and water molecules, offer high thermal storage capacity, though their melting points vary depending on the specific compound and its level of hydration. Eutectic mixtures, formed by combining two or more PCMs, are engineered to achieve specific, customised melting points by adjusting the ratio of components. Understanding these distinctions is critical in selecting appropriate PCMs for different building applications, ensuring optimal thermal performance and energy efficiency (Kuta et al., 2016) as shown in Table 2.

Table 2: Composition of different types of PCM
Source: Kuta et.al, 2016

Name	Types	Composition	Melting Point
Paraffin Waxes	Organic	Hydro-carbon chains	Between 20°C and 60°C
Fatty Acids	Organic	Carboxylic acids	Between 20°C to 50°C
Salt Hydrates	Inorganic	Inorganic salt with water molecules	Varies widely depending on the specific salt and its hydration level
Eutectic Mixtures		Mixture of two or more salts	Customised based on the mixture ratio

4.2 How do phase change materials work?

Phase change materials, or PCMs, utilise the latent heat that is absorbed or released during their phase transition process.

1. Absorbing heat: When a PCM gets warmer, it reaches a certain temperature where it starts to change state (like melting from solid to liquid). At this point, the PCM takes in large amount of heat without getting much hotter. This heat helps break the bonds between the particles in the solid, turning it into a liquid.
2. Storing energy: PCMs, once fully liquefied, can reliably and efficiently store thermal energy for extended periods. This stored heat, absorbed from sources like the sun during the daytime, can be released later when the surrounding environment cools.
3. Releasing heat: As the environment cools, the PCM gradually solidifies, releasing stored heat. This heat can be used for various purposes, such as maintaining the building's temperature during cold periods.

4.3 Applications of phase change materials

PCMs can be used in many different industries because of their flexibility in application. Some of the most common uses are as follows:

1. **Buildings:** Phase change materials (PCMs), such as paraffin wax and salt hydrates, can be incorporated into building materials for walls, floors and ceilings. These materials work by absorbing excess heat during the day and releasing it at night to help maintain a consistent indoor temperature.
2. **Solar energy storage:** PCMs work by storing extra solar energy collected during the day and releasing it during the night, making solar heating systems efficient. Sodium sulfate decahydrate is an example of PCMs used in solar energy systems (Cui et al., 2017).
3. **Refrigeration and cold storage:** Refrigerators and cold storage have a lining of PCMs to ensure the temperature stays cold during power-off or during transportation. A mix of ammonium chloride and water is used to keep it cool.
4. **Textiles:** PCMs are added into clothing to help control body temperature, keeping the person wearing it warm or cool depending on the environment. Paraffin wax is most commonly used in textiles.
5. **Heat pumps:** The PCMs store excess heat generated during the heat pump's operations. When the demand increases, the stored energy is released. The frequency of switching on and off reduces, helping to save energy and increasing the life of the compressor. Heat pumps most commonly use paraffin-based PCMs or salt hydrates due to their favorable thermal properties.

4.4 Advantages of using PCMs

1. Energy efficiency: Using PCMs reduces energy consumption by maintaining stable temperatures, as it decreases the dependency on heating and cooling systems.
2. Temperature control: PCMs help maintain a stable temperature, providing a more comfortable environment.
3. Environment-friendly: Many PCMs are eco-friendly and help with energy-saving efforts.

4.5 Challenges of using PCMs

1. Price: Some PCM's are high-quality and thus very expensive, which might be a deterrent for widespread application.
2. Durability: Organic PCMs degrade over time, impacting their performance.
3. Research and development: Proper integration and effective use of PCMs in existing systems and materials require further research and development.

Phase change materials are a major advancement in managing heat and improving energy efficiency. Their special feature of storing and releasing heat can be used in many ways to support sustainable methods in different fields. By learning about the types, compositions and mechanisms of PCMs, we can better understand their importance in current technology and energy solutions.

5. Software simulation and analysis

The software simulations yielded comprehensive data on the thermal behavior of both wall sections. Comparison of the results highlighted the differences in thermal conductivity, thermal resistance and overall energy performance between the conventional and innovative wall sections. The findings underscored the potential benefits of using advanced materials in enhancing the energy efficiency of buildings.

5.1 ANSYS

ANSYS software, developed by ANSYS, Inc., is a comprehensive suite of engineering simulation tools that empowers engineers and scientists to simulate and analyse the behavior of structures, fluids and electromagnetic fields under various conditions. ANSYS software is a versatile tool for solving complex engineering problems. It has a wide range of applications, including structural analysis, fluid dynamics, heat transfer, electromagnetics, acoustics and multiphysics. The software finds extensive use across diverse industries such as aerospace, automotive, biomedical, civil engineering, electronics, energy and manufacturing. By providing valuable insights into product behavior and performance, ANSYS enables engineers to optimise designs, identify potential flaws early in the development process and ultimately reduce product development time and costs.

5.2 Steady-State and Transient Thermal Analysis in ANSYS Software

A. Steady-State Thermal Analysis

Steady-state analysis, which is frequently employed to examine the behavior of a system under constant loads or boundary conditions, assumes that the conditions of a system remain unchanged over time. ANSYS provides a variety of solvers, such as the direct sparse solver and the iterative solver, to conduct this type of analysis.

In ANSYS software environment, Steady-State Analysis is a simulation tool employed to ascertain the long-term behavior of a system or component subjected to constant loads and boundary conditions. This type of analysis is crucial for evaluating the structural integrity, thermal stability and overall performance of a design when subjected to unchanging operating conditions. By neglecting transient effects and focusing on the equilibrium state, in Steady-State Analysis architects and engineers can effectively predict critical design parameters, such as stresses, deformations and temperature distributions. This ensures the reliability and safety of their designs. This information is essential for making informed design decisions, optimising performance and avoiding costly failures.

Steady-State Solvers:

1. Direct sparse solver: This solver is typically used for small to medium-sized models with simple physics. It is known for its fast solution times.
2. Iterative solver: This solver is typically used for large-scale models with complex physics. It is known for its ability to handle nonlinear problems.

B. Transient Thermal Analysis

Transient analysis takes into account the time-varying behavior of a system. This analysis is frequently employed to investigate how a system responds to dynamic loads or boundary conditions. In ANSYS, transient analysis can be performed using a variety of solvers, including the explicit solver and the implicit solver. Transient analysis in ANSYS software allows engineers to simulate the behavior of structures, fluids and electromagnetic fields over time. This type of analysis is particularly useful for studying dynamic events, such as the response of a structure to an earthquake or the flow of fluid through a pipe. Transient analysis can also be used to simulate the time-dependent effects of temperature, pressure and other environmental factors. By utilising transient analysis, engineers can gain insights into the behavior of their designs under real-world conditions. This information can be used to optimise designs, identify potential problems and ensure the safety and reliability of products.

Transient Solvers

1. Explicit solver: This solver is typically used for problems with high-frequency loads or boundary conditions. It is known for its fast solution times.
2. Implicit solver: This solver is typically used for problems with low-frequency loads or boundary conditions. It is known for its accuracy and stability.

5.3 Ansys Simulation Analysis

A comparative ANSYS simulation was performed to analyse the thermal performance of Bio-based PCM and Paraffin PCM integrated into brick wall assemblies. Using transient thermal analysis, both materials were subjected to identical boundary conditions representing a composite Indian climate. The results revealed that while both PCMs improved thermal insulation, Bio-PCM showed superior temperature regulation, delayed heat transfer and better alignment with sustainable building practices, as shown in Figures 2, 3 and 4. Simulation related to Bio PCM Brick are shown in Figures 5 and 6. Simulations related to Paraffin PCM Brick are shown in Figures 7 and 8.

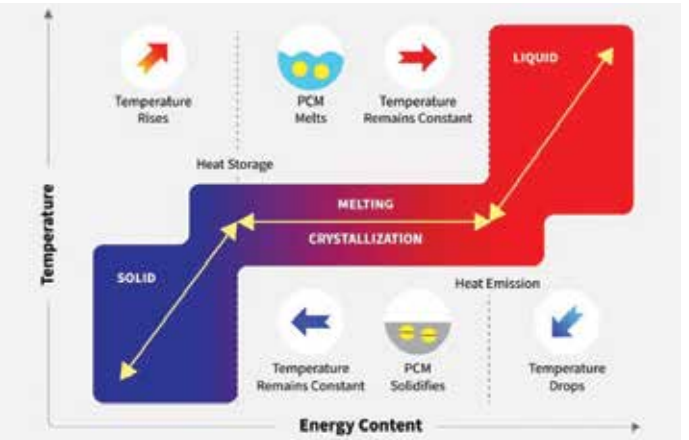

Figure 2: Working of phase change materials
Source: Kuta, M., et.al ,2016

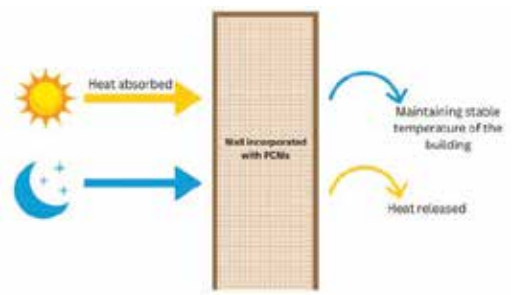

Figure 3: Walls insulated with PCMs helps to maintain a stable temperature of the building
Source: Cui Y, et.al ,2017

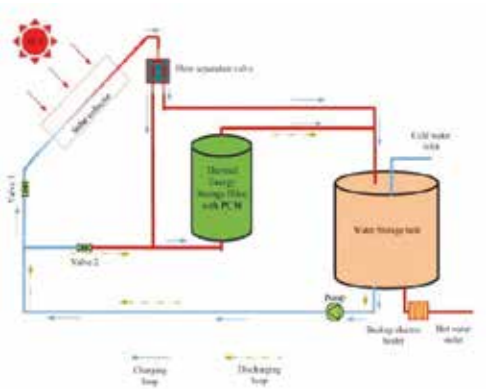

Figure 4: The arrangement of a PCM-based solar water heater
Source: Cui Y, et.al , 2017

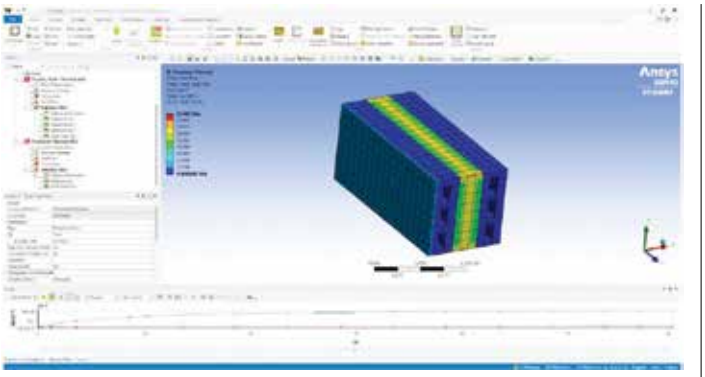

Figure 5: Transit Thermal Analysis of Bio PCM: Heat Flux vs Time
Source: Author using ANSYS

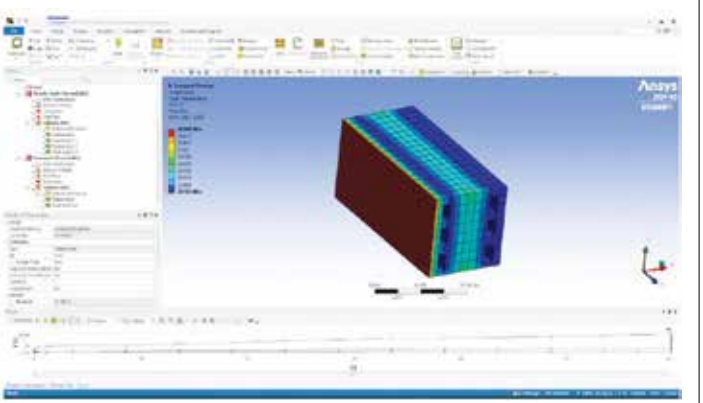

Figure 6: Transit Thermal Analysis of Bio PCM: Temperature vs Time
Source: Author using ANSYS

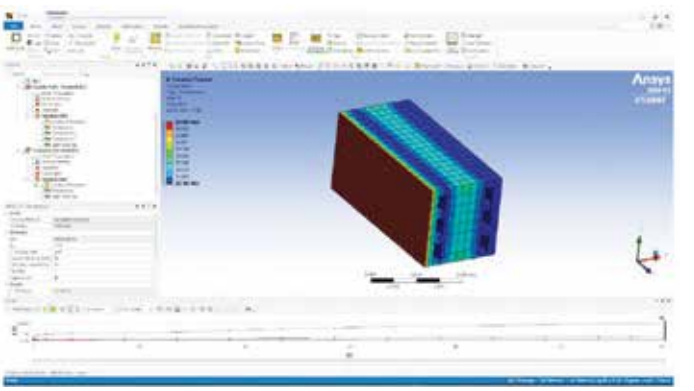

Figure 7: Transit Thermal Analysis of Paraffin PCM Brick: Temperature Vs Time
Source: Author using ANSYS

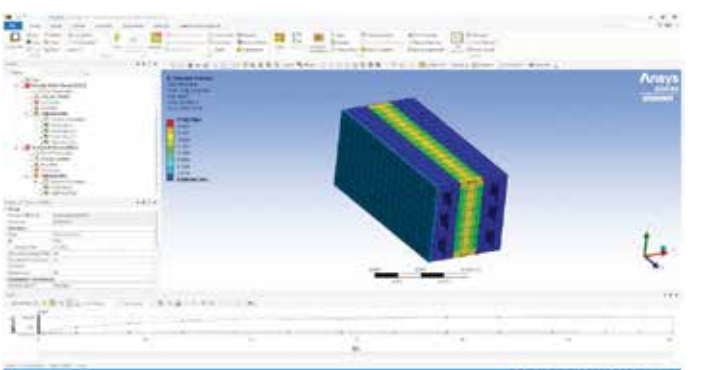

Figure 8: Transit Thermal Analysis of Paraffin PCM: Heat Flux Vs Time
Source: Author using ANSYS

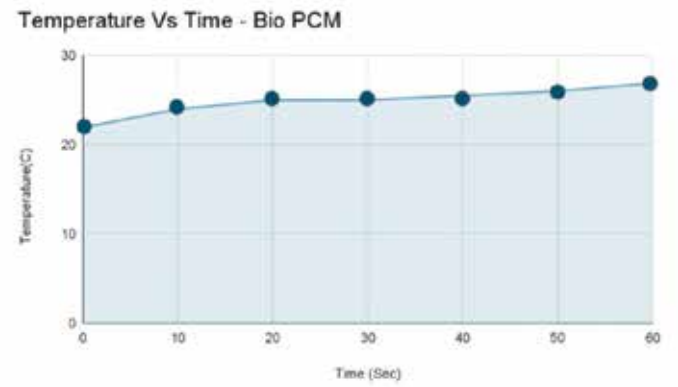

Figure 9: Temperature vs time graph of Bio PCM
Source: Author using ANSYS

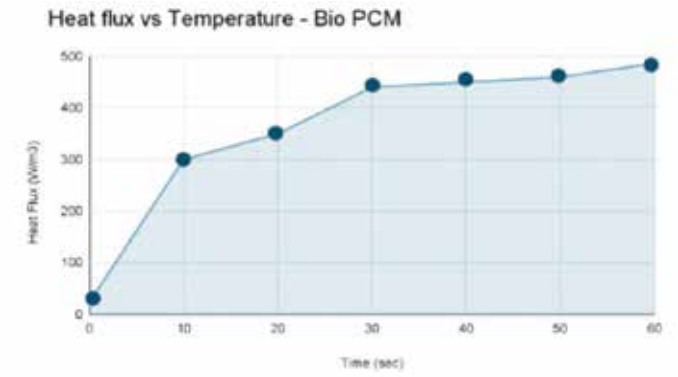

Figure 10: Heat flux vs time graph of Bio PCM
Source: Author using ANSYS

6. Discussion

A transient thermal analysis was conducted in ANSYS to evaluate the performance of Bio-PCM-integrated brick walls under dynamic temperature conditions. The simulation captured heat storage and release behavior over a 24-hour cycle, reflecting real-time environmental fluctuations. Results demonstrated that Bio-PCM effectively reduces peak interior temperatures and delays heat transfer, thereby enhancing thermal comfort and energy efficiency in residential buildings. A comparative analysis between Bio-PCM and Paraffin PCM-integrated bricks was conducted using ANSYS thermal simulations. The study evaluated parameters such as heat flux, internal surface temperature, and thermal lag under composite climate conditions. Results indicate that Bio-PCM offers more stable thermal regulation and enhanced sustainability compared to conventional paraffin PCM. Bio-PCM slab exhibits superior thermal conductivity compared to traditional insulation materials. This enhanced thermal performance is attributed to the unique ability of Bio-PCMs to absorb and release latent heat during phase transitions from maximum total heat flux 423.05w/m2 to 5.499w/m2 for the temperature to drop from 45OC to 22 OC. Unlike conventional insulation materials, which primarily JULY 2025 rely on conduction and convection, Bio-PCMs actively participate in the heat transfer process by utilizing their phase change properties. As shown in Figures 9 and 10, Bio-PCM slabs can effectively regulate temperature fluctuations, ensuring a more stable and comfortable environment while minimizing energy consumption when simulated in steady-state thermal analysis in ANSYS software.

The substantial amount of global energy consumption attributed to buildings necessitates a reduction in energy use within this sector to achieve environmental sustainability objectives. Phase Change Materials (PCMs) are innovative materials that can absorb and release thermal energy at specific temperatures. Incorporating PCMs into building components can significantly affect the thermal performance of a building. PCMs can maintain comfortable indoor temperatures by absorbing excess heat during hot periods and releasing stored heat during cooler periods. This heat regulation reduces the need for constant adjustments to heating and cooling systems, improving overall thermal comfort. By passively regulating indoor temperatures, conventional HVAC systems can be used less with the help of PCMs. This translates to a significant decrease in building energy consumption and associated costs. Bio-PCMs are a particularly attractive type of PCM due to their eco-friendly nature. They are derived from renewable resources like plant materials or organic waste, promoting sustainability in the construction industry. Bio-PCMs are generally non-toxic and pose minimal health risks, unlike some conventional building materials. Additionally, their recyclability allows for responsible end-of-life management, further reducing environmental impact. Research indicates that significant energy savings can be achieved by integrating Bio-PCMs into the building envelope. The thermal buffering effect of Bio-PCMs helps maintain comfortable indoor temperatures with reduced HVAC dependence. Bio-PCMs can be tailored to respond to specific human occupancy patterns within a building. This ensures efficient use of stored thermal energy, optimizing energy savings throughout the day. Bio-PCMs have the potential to be integrated into various building elements beyond just walls. Floors, roofs, and even concrete can be enhanced with Bio-PCMs for improved thermal performance. A common strategy involves embedding PCMs within the interior side of the building envelope, where they can directly interact with indoor temperatures. Combining PCMs with dynamic insulation materials offers even greater

energy-saving possibilities. Dynamic insulation allows for adjustable thermal resistance based on prevailing indoor and outdoor conditions. During hot weather, dynamic insulation can increase its resistance, preventing excessive heat gain indoors. Conversely, in colder weather, it can reduce resistance to allow for passive heat gain from the sun. Integrating PCMs with dynamic insulation systems can lead to significant reductions in both annual heat gains and heat loss. This translates to a more energy-efficient building with a smaller carbon footprint.

Bio-PCMs offer a sustainable solution for achieving thermal comfort and reducing building energy consumption. They combine energy savings with eco-friendly materials, promoting a greener construction industry. Further research is necessary to optimize the use of Bio-PCMs for various building types and climatic conditions. Additionally, developing scalable applications and cost-effective integration methods is crucial for widespread real-world adoption.

7. Conclusion

In summary, architects, engineers, and researchers have the ability to develop adaptive thermal envelopes that react to changing environmental conditions by utilizing the inherent capabilities of phase change biomaterials, which offer a revolutionary answer to the need for greater energy efficiency and thermal comfort in buildings. The use of phase change biomaterials will be essential in constructing sustainable, energy-efficient, resilient, and occupant-centric buildings as the need for green architecture rises globally.

1. The Energy-Guzzling Construction Industry: The substantial amount of global energy consumption attributed to buildings necessitates a reduction in energy use within this sector to achieve environmental sustainability objectives.
2. Phase Change Materials: Phase Change Materials (PCMs) are innovative materials that can absorb and release thermal energy at specific temperatures. Incorporating PCMs into building components can significantly affect the thermal performance of a building.
3. PCMs for Thermal Comfort and Reduced Fluctuations: PCMs can maintain comfortable indoor temperatures by absorbing excess heat during hot periods and releasing stored heat during cooler periods. This heat regulation reduces the need for constant adjustments to heating and cooling systems, improving overall thermal comfort.
4. Energy Consumption Reduction through Passive Regulation: By passively regulating indoor temperatures, conventional HVAC systems can be used less with the help of PCMs. This translates to a significant decrease in building energy consumption and associated costs.
5. Bio-based PCMs: Bio-PCMs are a particularly attractive type of PCM due to their eco-friendly nature. They are derived from renewable resources like plant materials or organic waste, promoting sustainability in the construction industry. Bio-PCMs are generally non-toxic and pose minimal health risks, unlike some conventional building materials. Additionally, their recyclability allows for responsible end-of-life management, further reducing environmental impact.
6. Energy Efficiency of Bio-PCM: Research indicates that significant energy savings can be achieved by integrating Bio-PCMs into the building envelope. The thermal buffering effect of Bio-PCMs helps maintain comfortable indoor temperatures with reduced HVAC dependence.
7. Adapting to Occupancy Patterns: Bio-PCMs can be tailored to respond to specific human occupancy patterns within a building. This ensures efficient use of stored thermal energy, optimising energy savings throughout the day.
8. Diverse Applications for Bio-PCMs: Bio-PCMs have the potential to be integrated into various building elements beyond just walls. Floors, roofs and even concrete can be enhanced with Bio-PCMs for improved thermal performance.
9. Strategic Placement for Optimal Results: A common strategy involves embedding PCMs within the interior side of the building envelope, where they can directly interact with indoor temperatures.
10. Dynamic Insulation: Combining PCMs with dynamic insulation materials offers even greater energy-saving possibilities. Dynamic insulation allows for adjustable thermal resistance based on prevailing indoor and outdoor conditions. During hot weather, dynamic insulation can increase its resistance, preventing excessive heat gain indoors. Conversely, in colder weather, it can reduce resistance to allow for passive heat gain from the sun.
11. PCM-Dynamic Insulation Systems: Integrating PCMs with dynamic insulation systems can lead

to significant reductions in both annual heat gains and heat loss. This translates to a more energy-efficient building with a smaller carbon footprint.

12. A Sustainable Path to Comfort and Efficiency: Bio-PCMs offer a sustainable solution for achieving thermal comfort and reducing building energy consumption. They combine energy savings with eco-friendly materials, promoting a greener construction industry.
13. Optimisation and Scalability: Further research is necessary to optimise the use of Bio-PCMs for various building types and climatic conditions. Additionally, developing scalable applications and cost-effective integration methods is crucial for widespread real-world adoption.

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ARTICLE

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Assessment of Urbanisation Impacts on Urban Lakes and Lake Communities

A Case of Bengaluru Lakes

By Ar. Kirti Parvati

Urbanisation is a population shift from rural to urban areas due to surplus opportunities in the urban areas. Due to rapid urbanisation in the Global South since 2015, the projected urban population in 2025 and 2050 will be 54.3% and 68.4%, respectively, of the total population of the Global South (UNDESA, 2019; UN-Habitat, 2013). So, the cities of the Global South are hit by intense urbanisation, especially the south Indian megacities like Bengaluru, Chennai and Hyderabad. Urban common resources located in urban areas have been severely affected by urbanisation. Due to the increase in population growth in urban areas, there is a considerable land demand, which is met by the expansion of peri-urban areas and overtaking the city's breathing spaces (urban commons like parks, open spaces, water bodies, etc.). Also, anthropogenic activities (human interventions with nature) have created stress on natural resources and the ecosystems, which has led to the degradation of the ecosystems. In this degradation process, the worst hit sectors are urban water bodies or urban lakes, and the surrounding communities. Bengaluru, a city of 1000 lakes, is no exception to this. Urbanisation has severely impacted the city's lakes and catchment areas, as a strong relationship exists between the lake and lake communities. Also, it is said that an urban lake reflects its watershed. This paper investigates various causes and effects of urbanisation and human interventions with lake ecosystems in the case of two lakes of Bengaluru, namely Sarakki Lake and Subramanyapura Lake of South Bengaluru and also their surrounding communities. Qualitative analysis has mostly been done to assess the impacts of urbanisation on these two lakes. The key findings are related to the land use changes over five decades, and most of the water bodies have disappeared and been replaced by built-up spaces. Proactive and integrated land use planning and continued monitoring are the need of the hour to protect the ecological value of lake ecosystems.

1. Introduction

1.1 Impact of Urbanisation on Urban Lakes

Urbanisation is the process of the concentration of the human population in urban areas, or it's a migration of people from rural to urban locations for several reasons. Some of the reasons are high-quality education, Job opportunities, Economic development due to proximity to jobs, safety levels, entertainment and lifestyle options, infrastructure and medical facilities, etc. (Arwvisions, 2023). The impacts of land conversion and changes in land use and land cover (LULC) on ecosystems have become an international concern due to the growing number of people living in cities. As per the 2011 census, by 2050, more than 60% of the Indian population will be urbanised. As the world becomes more and more urbanised, it becomes crucial to understand its impacts on both people and nature (Arwvisions, 2023). Cities are undergoing rapid and unplanned urbanisation. The exponential increase in population

growth of the cities demands more and more land, which is a scarce resource, especially in urban areas. To cater to this vast population of the city, the suburban or peri-urban areas are expanded. Also, the breathing spaces of the city, such as parks, open spaces, green spaces, playgrounds and waterbodies (Thippaiah, 2009), are being overtaken by real estate agents. In this process, the worst-hit sectors were the tanks or lakes in and around the urban areas (figure 1), as the ownership was easily manipulated. As a result, most of the urban lakes disappeared and were converted into housing layouts, bus terminals, huge apartment complexes, sports stadiums, etc. The disappearance of lakes has resulted in the loss of irrigated areas, drinking water sources and agricultural and recreational activities as well as the livelihood of fishermen and dhobis. Due to pollution, encroachments and the growth of water hyacinths and other aquatic weeds, even the existing lakes have become unfit as a source of drinking water. Urban floods have been created due to the loss of flood-absorbing capacity and have created chaos in the city due to disruption in the drainage networks.

Figure 1: The dynamics of urbanisation and impact on the ecosystem
Source: Authors

Bengaluru is no exception for such developments, and it's even worse when compared to other cities. The city was once known as the city of 1000 lakes (built during the period of the King Kempe Gowda to cater to the population for drinking, household uses, agriculture, fisheries and also for religious and cultural purposes (Thippaiah, 2009), Bengaluru was previously associated with many prefixes like Green City, Garden City, Pensioner's Paradise, Kalyana Nagari (City of Tanks/Lakes). Since there is no perennial river in the city, it has been depending on the tanks or the lakes for the water needs of the city. The city has three valley systems, namely, Hebbal Valley, Vrishabhavati Valley and Koramangala Challaghatta Valley (K-C Valley). Further, each of these valleys has five to six lake series. Each of these lake series has 4-5 lakes, each interconnected by upstream and downstream lakes, which were earlier interconnected by a system of network called rajakaluves. At present, these networks have been lost due to intense and unplanned urbanisation. Due to this issue, urban floods are happening in the city.

Urbanisation processes have led to significant global and local sustainability issues, both in India and around the world. The third largest city in India, Bengaluru, presents a typical challenge of the sustainability issues that many Indian cities face. With more than 10 million people living in a 709.5 sq. km area, the city has experienced a rapid population increase in recent years, rising by 38% between 1991 and 2001 and by 49% between 2001 and 2011(Patil et al., 2015). The process of urbanisation may have started in the late 1990s with the real estate boom and IT boom in the city. More and more people started coming to the city with IT job opportunities, and that was when the city became known as Silicon City. In contrast to many other cities, Bangalore is comparatively far from major rivers that can supply fresh water because it is located in the Deccan hills' rain shadow. Local leaders and communities in Bangalore skillfully exploited the undulating terrain of the surrounding area by damming a number of small, primarily seasonal streams to create numerous series of tanks throughout the greater area. This practice was also prevalent throughout a large portion of peninsular South India. Until the late 19th century, when Bangalore started importing water from far-off reservoirs and rivers, indicating the decline and degradation of many of these lakes, these dammed water reservoirs which were referred to locally as tanks or lakes, recharged the groundwater supply and supplied the city with a large portion of its water supply.

1.2 Impact of Urbanisation on Lake Communities

Lake communities are the settlements on the catchment area of the lake which are influenced by the lake ecosystem and vice versa. The communities have a sense of belongingness with the lake as they co-exist with the lake for many years. Urbanisation has impacted the communities around the lake ecosystem as well. The population increase, increase in the density, job opportunities, life style changes, increase in the land values have impacted the people

of the lake communities severely. The old agricultural land parcels of the lake communities were sold out and some people shifted to some other locality, some of them constructed new houses in contemporary style in the same locality by retaining their ancestral land.

1.3 Morphology of Urban Lakes

Morphology is the spatial changes over a period of time. Urban lakes have undergone spatial changes drastically in Bengaluru over a period of five decades as shown in figure 2. The changes can be seen from the year 1973 to 2021. In the year 1973, it was more of green spaces and water bodies and very less of built spaces. We can observe the increase in built-up spaces and reduction in green spaces and urban water bodies gradually. In the year 2021, we can see hardly any green spaces and water bodies in Bengaluru and it is mostly occupied by the built-up spaces to cater to the huge population of the city. Parks, green open spaces and water bodies have been encroached upon and converted in to other land uses like housing layouts, huge apartment complexes, sport stadiums, bus terminals etc.

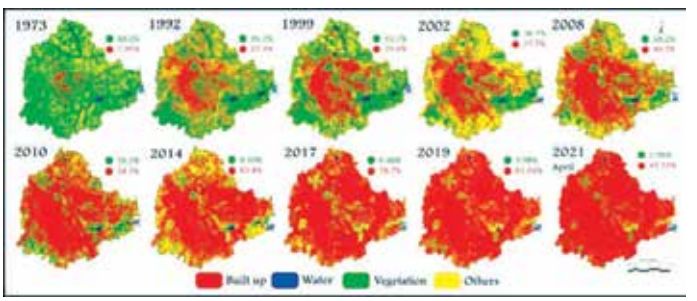

Figure 2: Urbanisation - land use changes over five decades
Source: Dr.T.V Ramachandra, IISC, Bangalore

Lakes were traditionally governed by the villages around them, perhaps with financial and administrative assistance from the local authorities. Other groups were allowed to use the lake for certain purposes like fishing, gathering fodder, or agriculture, while certain kin groups were in charge of tasks like desilting or maintaining the lake's canals and bunds. Later, formal administrative systems imposed by the Mysore Principal state and British government agencies supplanted these specialised, seasonally assigned responsibilities (Nagendra et al, 2016).

The Department of Minor Irrigations, Department of Fisheries, Department of Ecology and Environment, Karnataka Forest Department, Lake Development Authority, Karnataka State Pollution Control Board, Bangalore Development Authority, and the BBMP are just a few of the bewildering array of government departments with overlapping jurisdictions involved in various aspects of lake management are just a few of the bewildering array of government departments with overlapping jurisdictions involved in various aspects of lake management (Nagendra, 2010). Public interest lawsuits, civic action groups' (including the Environment Support Group's active participation), and the Karnataka courts' intervention have been crucial in securing legal protection for the city's remaining lakes against development and encroachment (Nagendra et al, 2016).

1.4 Aim and Objectives

The aim of this research is to protect the lake ecosystem and its surrounding communities from being impacted by intense urbanisation. The objective of the paper is to evaluate the impact of urbanisation on urban lakes and the surrounding lake communities.

2. Literature Review

An extensive literature review made it evident that there are many studies on the impact of urbanisation on urban lakes, whereas no studies on the lake communities. As an urban lake reflects its watershed, it is also important to study its catchment area. Their integration plays an important role in the sustainable development of an urban lake ecosystem and its surrounding communities.

In 'Time-Line Based Aerial Analysis for Impact of Rampant Urbanisation on Lakes of Bengaluru', a team led by Rajesh Gopinath (Gopinath et al, 2022) noted that the research reveals that about 90% of lakes under the purview of the present study were encroached on by an average of 7.39%. Bellandur and Varthur Lakes have witnessed the highest decline with encroachment of 9,87,411 sq.m and 1,33,205 sq.m respectively. As fresh-water is a scarce non-renewable commodity, a thorough analysis is warranted to understand the trend to arrest the impending situation and incept remedial measures. Literature review and cartographic studies were carried out to identify the existing lakes of Bengaluru. Bengaluru is one of the most densely-populated cities in the world, yet its lakes have lost more than 20% of their physical area in the last decade.

A new set of metrics to assess the ecological status of urban lake environments has been developed by researchers. Santhanam & Majumdar, 2022, studied quantification of green- blue ratios, impervious surface area and pace of urbanisation for sustainable management of urban lake and land zones in India – a case study from Bengaluru city. Impervious surface area per person in India has been estimated to be about 76.7 sq.m. The nation has been classified as

one with a high concentration of primary watersheds damaged by impervious surface area. More than 3% watersheds, with 25–100% ISA, are found in parts of Karnataka, Tamil Nadu and Andhra Pradesh in South India. One of the key indicators of rapid urbanisation in a given region is the loss of water-spread regions and green coverage.

Research on the impact of urbanisation on urban lakes and their communities highlights several key issues. Urbanisation often leads to the degradation of water quality in urban lakes due to increased pollution from industrial activities, domestic waste and runoff from impervious surfaces. For instance, a study on Bengaluru lakes demonstrated significant water quality deterioration, primarily due to idol immersion activities and runoff-containing pollutants (Birawat et al, 2021).

The spatiotemporal evolution of lakes in rapidly urbanising areas, such as Wuhan, China, has shown a notable decrease in lake area and landscape quality. However, there have been some improvements in lakefront ecology attributed to better management practices and increased economic investments (Wen et al, 2021). The increase in GDP and improved ecological indices around lakefront areas contribute to lake restoration, though the growing population and impervious surfaces often exacerbate lake degradation.

Community well-being is also a critical component of urban lake ecosystem health. Ensuring the health of urban lakes involves addressing human health risks, maintaining biodiversity, and providing recreational spaces for urban populations are all important aspects. Integrated urban ecology approaches, which consider both ecological and socio-economic factors, are essential for sustainable urban lake management (Walker et al, 2013). These findings suggest that while urbanisation poses significant challenges to urban lake ecosystems, strategic management and policy interventions can mitigate adverse effects and promote restoration and conservation efforts.

3. Methodology

In this paper, mainly the social and economic factors and spatial factors have been focused on. Social and economic factors are further having the three parameters.

3.1 Social and Economic Factors:

- Community engagement: Conducted surveys and interviews with local residents, businesses and recreational users to understand perceptions, concerns and impacts on their activities.
- Property values: Analysed the property values around the lake to assess the economic impacts of changes in lake condition.
- Recreational use: Evaluated changes in recreational activities such as fishing, boating, and swimming.
- Spatial aspects: Evaluating the impact of urbanisation on urban lakes and lake communities in terms of spatial aspects involves assessing various spatial dimensions and changes that occur due to urban growth.

The above factors were evaluated through a pilot survey done on the lake premises.

The following are the steps and parameters considered in the case of two lakes to undertake the urbanisation impact assessment.

- Size and shape changes: Measured changes in the size and shape of the two lakes over time using satellite imagery, historical maps, or GIS data. Urbanisation often leads to alterations in the natural contours and boundaries of lakes due to land reclamation, dredging or construction.
- Surrounding land use: Analysed the land use patterns around the lake. Urbanisation typically involves the conversion of natural landscapes (forests, wetlands) into built environments (residential, commercial areas), affecting the hydrology and ecology of the lake.

The above aspects were assessed through Google Earth maps and current land use maps.

3.2 Area of Research

Two lakes of Bengaluru South are selected for the research (figure 3). Sarakki Lake, one of the largest lakes, is located in the suburb of J.P Nagar. Formerly, it covered an area of 84 acres (34 ha). The word “Sarakki” means “Saavira Hakki” in Kannada which means a lake of 1000 birds. Though the lake belongs to Jaragana Halli Ward (ward No.186), Puttenahalli Ward (ward No.187), and Sarakki Ward (ward No.178) are very close by and are part of the catchment areas of the lake. The lake is surrounded by five villages. The Jaragana Halli community had goldsmiths, the Sarakki communities were farmers, the Puttenahalli community had Goudas and Vokkaligas, the Chunchaghatta communities were Kurubas had shepards and Kothnur communities had skilled labourers (Bhat, 2022) These communities co-existed with the lake for a long time till the onset of the urbanisation. They took care and maintained the lake ecosystem and utilised its services. They had a sense of belongingness and ownership of the lake. They followed a give-and-take policy. The area

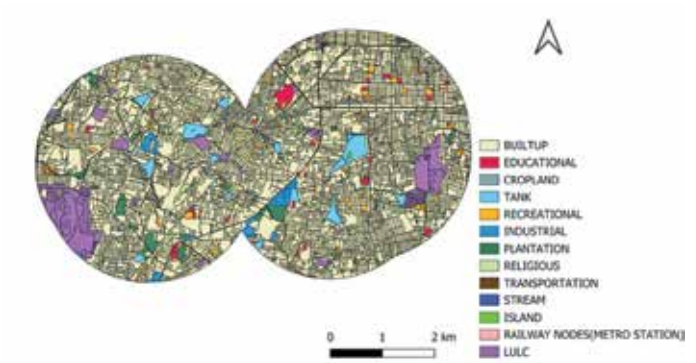

Figure 3: Current land use map of the study area of Sarakki Lake (right) and Subramanyapura Lake (left) showing the high percentage of built-up area
Source: Authors

around the lake was mostly agricultural, and the farmers from the Sarakki Thota grew mainly sapota plantations and also sowed ragi and rice pads (Bhat, 2022) around the lake; the dependent livelihoods were happy with what was sown and grown. The community maintained a harmonious relationship with the lake ecosystem. In 2013, 34 acres had been encroached on by private builders (there were 135 encroachments to the lake area). As per the high court order in 2015, there was a 10-day eviction drive to clear the encroachments. The lake belongs to the K-C Valley (Koramangala-Challaghatta Valley) and Puttenahalli Lake series. In 2012, the Sarakki Lake Improvement Trust (SLAIT) was formed to make efforts to revive the lake. Currently, the catchment area of the lake has a population of about 2 lakh.

Another lake, Subramanyapura Lake, which is 4 km away from Sarakki Lake, has 19 acres of area and is currently partially revived. The lake belongs to Uttara Halli ward (ward No.184). Once, the lake was a swimming lake, and the informal settlements around the lake were highly dependent for their livelihoods. A range of ecosystem services benefitted the surrounding settlements. Now, the lake is surrounded by high-rise, large apartment complexes on two sides and by informal settlements on the other side. As per the LULC (Land Use Land Cover) map of Karnataka State Remote Sensing Applications Centre (KSRSAC), the lake comes under a peri-urban area, but the area is fully urbanised with high-rise buildings on its two sides. The two sides of the lake are highly urbanised with the high-profile people living in the apartment complexes, whereas the other sides are having marginal communities living in the low-cost housing project by Slum Development Board. Due to intense urbanisation, the vulnerable settlements are deprived of their livelihood. The lake belongs to the K-C Valley and Byramangala Lake series. Both the lakes belong to the Bommanahalli Zone and are under the custody of BBMP.

4. Data Analysis and Findings

The analysis of the collected data with respect to Sarakki Lake is done as presented. The Google Earth maps over a period of time (from 2010-2024) show the drastic change in its size and shape (figures 4 and 5).

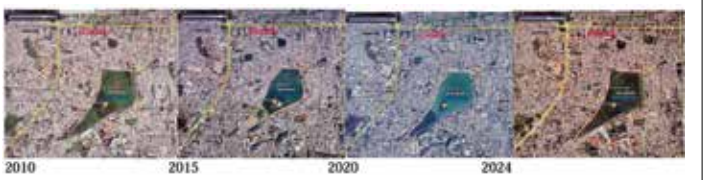

Figure 4: Images of Sarakki Lake from the year 2010 to 2024
Source: Google

Figure 5: Images of Subramanyapura Lake from the year 2010 to 2024
Source: Google

4.1 Analysis

A pilot survey was carried out for 50 people in both lakes through a random survey. Following are the important points noted as per the survey analysis.

- Most people stated urbanisation has taken place due to an increase in the population, density and built-up spaces. Also, most of them said the increase in land values has created land demand.
- The reason for the current status of the lake and its surrounding communities is the non-involvement of the community people in the lake rejuvenation and its maintenance process and the lack of awareness about the benefits of the ecosystems.
- Urbanisation has impacted the marginal communities the most due to the loss of their livelihoods.
- People were of the opinion that, in the future, there is a need to create awareness of community participation among the youth and children of the neighbourhoods.
- The ecosystems will contribute to a large extent, making the neighbourhoods sustainable.

4.2 Findings

It is found that from the land use and Google Earth maps of both Sarakki and Subramanya Pura Lakes, the built-up areas have increased multifold, whereas the parks, open spaces and water bodies are on the verge of disappearing. There are very minimal lung

spaces in both neighbourhoods, which is the lake itself! In figures 6 and 7, the ASI maps of 1976 and 1972, show very less of built-up spaces and more of green and open spaces where as in SOI map of 2011 in figure 8 shows more of built-up spaces and less of green and open spaces. But in current land use map as per figure 9, the catchment area of the lake is full of built-up spaces except the lake area as a lung space. Within a one km radius of Sarakki Lake, the green spaces are negligible, i.e. 0.06%, which is highly alarming. Whereas 80.57% is filled with built-up spaces, which means impervious spaces have drastically increased due to which groundwater recharge has drastically reduced.

5. Results and Discussion

Figure 3 shows the current land use map of the study area of Sarakki Lake and Subramanyapura Lake, showing the high percentage of built-up areas in the catchment areas of both lakes. The Sarakki Lake is highly urbanised on its two sides, with high-profile people and multi-storied buildings. On the other two sides, it is surrounded by LIG and MIG people. So, the catchment area of the lake is a mix of all three classes of people. In the case of Subramanya Pura Lake, one side of the lake is fully covered by multi-storey apartment complexes, whereas the opposite side is full of buildings for informal settlements built by the Karnataka Slum Clearance Board. The other two sides are of MIG people. So, the catchment area of this lake is also a mix of all classes.

The Google Earth images in figure 4 show the changes in Sarakki Lake, in its size and shape, from the year 2010 to 2024. This is a clear indication of the intense urbanisation around the lake area. The

Figure 6: Subramanyapura land use map
Source: ASI map 1976

Figure 7: Sarakki Lake land use map
Source: ASI map 1972

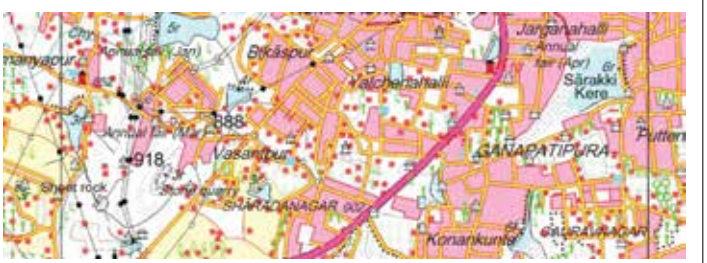

Figure 8: Survey of India 2011 land use map highlighting the two lakes
Source: SOI Open Series Map

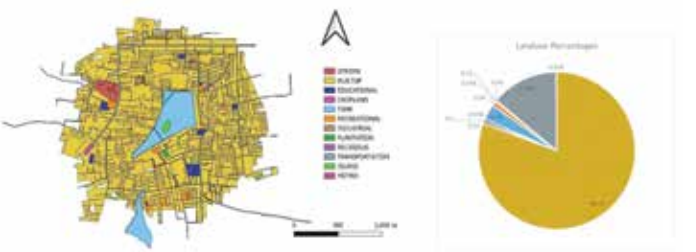

Figure 9: Current land use map of the study area of Sarakki Lake and its surroundings covering 2km from the centre of lake along with the percentages.
Source: Authors

lake area has been reduced from 82 acres in 24 gunthas (as per RTC) to 73 acres in 32 gunthas (as per the topographical survey). The present water spread area has shrunken to 55 acres 10 gunthas. The current land use map, 1 km from the centre of the lake, shows the maximum built-up area, which is 80.57% around the lake area, which is a clear indication of rapid urbanisation in the catchment area of the lake. Other land uses, like parks and open spaces, water bodies etc, have been reduced drastically with the increase in population and built-up spaces in the catchment area. The transformation of Subramanyapura lake can be observed in the Google Earth images of figure 5. It can be noted that from 2010 to 2024, there has been a drastic change in the size and shape of the lake area. Gradually, the

lake area was shrunken. The size of the original lake was 19 acres, 31 gunthas; now, it has been shrunken to 16 acres due to the encroachments and dumping of waste on the lake edge.

The implications of urbanisation on Sarakki Lake communities have been severe for the marginalised people. Earlier, the communities depended on the lake ecosystem for their livelihoods, for fishing, washing and grazing grass for cattle. The farmers did cultivation for the family and the community people. The lake was used for various purposes. The lake was surrounded by sapota plantations; they also grew ragi and rice paddy. Agriculture was the primary occupation of Sarakki Thota communities. They looked after the lake ecosystem and also earned their livelihood. The increase in population and so the built-up spaces have given rise to the encroachments on the lake premises and polluted the lake by dumping solid waste and connecting the sewage line to the lake directly. These anthropogenic activities have directly impacted the lake ecosystem services. Hence, the marginal population is deprived of the ecosystem services. The high-profile people with very little concern about the protection of nature have settled in the lake catchment area. In the case of Subramanya Pura Lake, the impacts are more on the informal settlements on one side of the lake as they are also deprived of their livelihoods. In the current condition of the lake, it's inaccessible by the surrounding community people. There is no participation of the community people in the maintenance of the lake.

6. Conclusions and Recommendations

The impact of urbanisation on both the lake and the surrounding communities are similar in both the lakes. The increase in the population, population density, land values, and built-up areas have created exponential growth patterns in the catchment areas of the two lakes over a period of 15 years. In the context of Bengaluru, unplanned urbanisation has taken over the majority of city lakes in the name of infrastructure developments. Recently, the Resident Welfare Association (RWAs), the local government (BBMP) and NGOs have come together to revive some of the lakes. The importance of the lakes is being felt now due to the severe water crisis in the city. It is important to reimagine and bring back the legacy of the pristine lake and the surrounding communities from its historic past to its current status. The lake area has witnessed paradigm changes for the past 2-3 decades in terms of demographic, geological and spatial aspects. When we look at the land use changes of the catchment area, in various time periods as shown in figures 8 and 9, the built-up area has increased more than tenfold than in the past. This was due to an increase in population and demand for infrastructure developments.

A lake reflects its catchment area. Hence, it is important first to identify any notable shifts or patterns in the main land uses in the catchment area or watershed that flow into the lake. Therefore, it is crucial to conserve our lakes in integration with the surrounding lake communities. The collaboration of the governance and community people will give rise to integrated sustainable communities. When the land use maps of SOI 1972 and 2011 were compared, it clearly says that the built-up area has increased multifold, and in the current land use map, the built-up area is 80.6%, and in the remaining 19.4%, other land uses have been divided. This map itself indicates the rapid urbanisation and very minimal lung spaces remaining in the area, which is a lake itself! Hence, there is an urgent need to protect and revive the lake, its premises and surrounding communities for harmonious and sustainable development. There are opportunities for the development potentials of lake and lake communities in terms of social, economic and ecological aspects to make the area self-sustainable. In line with the UN SDG 11-Sustainable Cities and Communities, a self-sustaining community can meet its needs without relying on external systems or resources. However, this doesn't necessarily mean complete isolation from the wider world but creating a community that is adaptable and capable of supporting itself in a resource- efficient manner.

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ARTICLE

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Social-Ecological Systems Approach

Towards Green Infrastructure Planning for Urban Resilience

A Literature Review

By Aggin Maria James and Dr. Amritha P K

1. Introduction

The term "Green Infrastructure" (GI) had its beginning in landscape architecture in the early 1990s. Over the years the term was redefined by many scholars. Most of the current definitions of GI consider it as a multifunctional network of terrestrial and aquatic ecosystems that are naturally occurring, human- made or human-modified; that provide basic essential ecosystem services to the human society and maintains biodiversity. Ecosystem Services (ES) refer to the various benefits that ecosystems provide to humans and other living organisms (Lovell & Taylor, 2013). These services are essential for supporting life, well-being, and economic activities (Meerow, 2020). They are categorised into provisioning, regulating and cultural services. Their contributions range from essential resources like food and water to the regulation of climate, purification of air and water, and the provision of cultural and recreational experiences (Finlayson, 2016). Interconnected and interdependent, these services sustain life, underpin economies, and underscore the profound link between healthy ecosystems and human prosperity (Finlayson, 2016).

The ES provided by GI in urban context includes cultural services which include recreation, scenic quality and interactive spaces and regulating services such as maintaining the water balance, reduction of pollution and mitigating Urban Heat Islands (UHIs) (Hansen & Pauleit, 2014; Lourdes et al., 2022; Meerow & Newell, 2017). The cultural services provided by GI is different for different social groups. GI is more appreciated for its aesthetic quality, recreation and spiritual value by people of wealthier social groups (Calderón-Contreras & Quiroz-Rosas, 2017). In case of lower income groups, the provisioning services of GI like food, medicinal products and fire wood are seen to be more important. Urban farming practices also provide livelihood for low-income communities. Regulating services such as providing clean water and cooling effect of GI are also more important for these social groups (Adegun, 2017).

1.1 Social-Ecological Systems

For a long time, the human society was considered as a separate entity from the nature, where humans acted up on and modified the ecological system (Coates, 1998; Goudie, 2009). But since the 1970 an awareness on the intricate connection between the nature and the human society began to develop and many advocates emerged for viewing human society as a part of the nature and not as separate from it (Folke, 2006; Glaser et al., 2012). It is from this realisation that the Social-Ecological System (SES) view emerges. Social-ecological systems (SES) refer to systems in which social and ecological elements are interconnected and mutually influence each other, forming an integrated system with reciprocal feedback and interdependence, positioning people not apart from nature but as a very involved, active part of it (Lovett, 1999; van der Jagt et al., 2019). Here the term social indicates all the sub elements of the society such as economy and culture. In this

interdependence and co-evolution of social and ecological components, the dynamic and complex nature of the interactions between people and their environments is highlighted. In this approach the "people, communities, economies, societies, cultures are seen as embedded parts of the biosphere and shape it, from local to global scales" and the separation between the social and ecological is seen as arbitrary (Voghera & Giudice, 2019). SES approach has great significance in the study of system resilience (During et al., 2022).

The term resilience refers to the ability to adapt or bounce back, and recover from adversities, challenges, or setbacks. This includes the capability to withstand and overcome impacts, as well as to learn and grow from the process (Walker et al., 2004). A system resilience is when a system can maintain its connections and processes in a stressful situation, during changes or impacts without effecting its overall function, and adapt to new situations. In this sense the SES approach is directly linked to resilience of the whole system as it provides a better understanding towards the relationship between people and nature where humans can be viewed as a part of the natural system. (Huff et al., 2020). Thus, the concept of social-ecological systems resilience acknowledges that human well-being and environmental health are closely linked and that sustainable and resilient solutions need to consider both social and ecological dimensions.

1.2 Social-Ecological Systems and Green Infrastructure

Social and ecological components of the SES are linked through a feedback loop. The intensive anthropogenic activities in the urban scenario directly and indirectly results in harming ecosystems and loss of biodiversity (During et al., 2022). This results in a decline of the essential and critical services required for the survival and wellbeing of the urban society. Thus, leaving both the ecology and the human society in a vulnerable condition. To overcome such a situation it is important to develop social-ecological resilience, where urban development and urban ecosystems support each other and benefit from each other. One way to achieve this is through GI, as it can be implemented to provide essential ES to the urban society and enhance ecosystem health thus achieving as state of social-ecological system resilience (Lieberherr & Green, 2018; Meerow & Newell, 2019; Reynolds et al., 2022). Increased urbanisation and developmental activities reduce green cover and ecosystems in cities. In such cases, GI becomes a method by which the society can help the city's ecology to become resilient by protecting the existing natural and semi-natural areas and creating new, modifying existing and connecting fragmented ecosystems in such a way that it enhances biodiversity and ecosystem health, while also satisfying the ES demands of the society.

Community engagement plays a key role in successful implementation of GI. Here the GI is dependent on the society to protect and maintain it sustainably and society is dependent on the GI for its ES. Therefore, social acceptance of GI and understanding of it as an essential service providing infrastructure is needed for the resilience of the SES. The health and wellbeing of people and communities are linked to their access to good quality green spaces and ecosystems. There are several studies that suggest that proximity and access to GI, is correlated with better physical and mental health, a greater sense of community and social justice, and provision of livelihood and nutrition for the communities (Calderón-Contreras & Quiroz Rosas, 2017; Cilliers et al., 2018; Gopal & Nagendra, 2014; Li et al., 2020; Meerow, 2020; Reynolds et al., 2022). Meanwhile, in socially secure communities it will be easier for people to care about the environment thus social resilience can strengthen ecological resilience (During et al., 2022). The ES provided by GI like reduction of pollution, maintaining the water balance thus preventing flood and drought, keeping the city cool and, providing food, raw materials and medicine point towards a more resilient society. GI also acts as a space where people can engage in activities like exercise, meditation, relaxation, social interaction and spiritual activities, thus increasing physical and mental wellbeing and, increase social capital which are also signs of a resilient society. Thus, as the GI provides essential ES to the society, the people will be motivated to further protect and maintain it, ultimately creating a resilient social-ecological system.

The above discussed aspects points towards an idea that understanding the SES dynamics in an area and planning and implementing GI from a SES lens would lead to better resilience of the GI created and the society in which it is situated. This paper aims to gather all the reputed academic literature that discusses the SES approach towards planning and implementation of GI in urban areas and analyse them to develop and understanding of various areas of focus on this approach and to understand how it leads to better system resilience.

2. Methodology

Electronic data bases of Scopus and Web of Science were searched on 20th June 2024, using the key words " green infrastructure" and "social-ecological system" to obtain eighty-two and forty-two articles respectively. This included research papers and articles published in peer reviewed journals, book chapters and conference proceedings. These were then screened for their relevance after removing duplicates. During the screening the abstracts of the articles were scrutinised using an inclusion exclusion criterion which is given in table 1.

A total of forty-two articles were selected for review after the initial screening. The whole article was read at the next stage and five articles were removed due to their lack of relevance for the study and another ten relevant articles were added from backward and forward citation. Finally a total of forty-seven articles were analysed.

The analysis included identifying key themes emerging from GI planning via the SES approach and examining their roles in enhancing system resilience. From the initial analysis four major themes evolved that are; public participation in GI planning, the significance of economically weaker sections in resilient GI planning, social systems shaping ecology and ecological systems shaping the society and, collaborative approach. It was further analysed how each of these themes can be used as a part of the social-ecological systems approach in planning GI and how it leads to better resilience. These findings are discussed in detail in the next section.

3. Findings and Discussion

This section discusses the findings from the literature reviewed. One of the overarching themes in the literature reviewed is the importance of public participation for resilient GI planning. When the public is involved in GI planning and implementation the SES approach is in play here.

3.1 Public participation in GI planning

When GI is developed through citizen's initiatives and social stewardships as a part of people's daily life it takes diverse forms that has the potential to re-link social and ecological systems in a more resilient manner (During et al., 2022). This leads to more successful and resilient GI interventions where ecosystem health is maintained and the ES demand is successfully met (Andersson et al., 2014). Here, as the social demands for ES is met by the local GI through diversification and multifunctionality, people tend to form a deeper attachment to the GI closer to them, which leads to a better sense of community leading to social cohesion and social justice that can be translated into more resilient cities (Calderón- Contreras & Quiroz-Rosas, 2017; Haruna et al., 2018). If social element of the system is not adequately addressed in GI planning it can result in inequities such as green gentrification and socially vulnerable areas receiving minimal GI interventions (Chen et al., 2020; Shokry et al., 2020). Therefore, the consideration of social aspects such as who will be benefited by the GI and where it needs to be placed so that it provides maximum equitable benefit to both the society and ecology is essential (Meerow & Newell, 2019b). Thus, urban GI developed through public involvement shaped by the political, economic and social-cultural context, is crucial for achieving resilient socio-ecological systems that are truly equitable and sustainable (Alfie-Cohen & Garcia-Becerra, 2022; Egerer et al., 2024; Jones & Russo, 2024).

Table 1: Inclusion exclusion criteria
Source: Author

Criteria	Decision
The keywords exist as a whole in title, keywords or abstract section of the paper.	Include
The paper is published in a scientific peer-reviewed journal	Include
The paper should be written in the English language or English translations are available	Include
The main focus of the paper is on GI or elements of GI and SES approach	Include
The paper focuses on areas with urban character.	Include
The paper has implications in spatial planning.	Include
The main focus of the paper is not on GI or elements of GI	Exclude
The case areas are of rural character	Exclude
The paper does not have implications in spatial planning	Exclude
Papers that are not primary/original research	Exclude
The paper is not accessible in English language	Exclude

There are different forms of public participation that were addressed in various studies. GI in the form of community gardens and social stewardship projects act as tool for transmitting and modifying social and ecological knowledge over time and space that will be enhanced by social diversity (Cilliers et al., 2018). Thus, they become a space of social-ecological memory that fosters gardening skills, cultural traditions, and nutrition. When GI gets implemented through such a participatory approach, not only does the citizens involved become more interested in caring for ecosystem it also improves overall stakeholder salience through social networking thus building social capital (van der Jagt et al., 2019; Welsh & Mooney, 2014). Private ownership of GI in various forms such as institutional green spaces and home gardens is another form of public participation where the owners have the responsibility for taking care of the ecosystem as they are the ones who primarily enjoy the ES provided by these GI; yet several ES provided by these spaces like air quality improvement, flood regulation and heat reduction are extended to the surrounding communities as well (Kim, 2022; Santos et al., 2022). Especially in places where larger portion of land is owned privately, the participation of citizens and institutions in creating GI on their properties has a strong potential for creating a more sustainable regime through a participatory management (Lieberherr & Green, 2018). Involving citizens in the decision-making process is an important form of participation in GI planning. Local communities will have rich knowledge about the natural ecosystem of their surroundings; utilising stakeholder knowledge in GI modelling and planning helps enhance urban resilience (Coletta et al., 2024; Jones & Russo, 2024; Khirfan & El-Shayeb, 2020). While taking into account the multi hazard risk to the SES, local knowledge can become useful for planning GI networks to ensure resilience in the face of the changing climate (Ou et al., 2022). Also, decision support tools involving public opinion encourage action toward implementing a preferred solution could allow for creativity and local empowerment (Hamel et al., 2021; Lovell & Taylor, 2013). Thus, contextually situated reflexive decision making and co-creation results in green placemaking and climate resilience based on socio-ecological principles such as human well-being and community-based decision making (Gulsrud et al., 2018).

3.2 The significance of addressing economically weaker sections in resilient GI planning

The connection between the economically weaker sections and GI is another major theme that is discussed as a part of the social-ecological system approach. The poor urban households largely in the developing countries tend to be located close to ecologically significant areas such as river banks, wetlands and steep slopes (Adegun, 2017). It can be observed that these people protect and conserve the ecosystem they live in since they draw major benefits from them in the form of various ES including provisioning services such as clean water, food, medicine and firewood, regulating services like micro-climate moderation (heat and wind) and flood control and socio-cultural services such as spaces for recreational activities, social interaction, cultural expression and being objects of spiritual or religious importance (Adegun, 2017; Derkzen et al., 2017; Gopal & Nagendra, 2014). In the economically weaker communities, there is more dependency on the provisioning and regulating services of GI over its recreational factor which is more highlighted in wealthier areas (Adegun, 2017). In this context, GI in cities can provide people an opportunity to forge various items including food, medicine and raw materials thus enjoying benefits such as financial benefits, health benefits and better mental health through interaction with nature (Hare & Peña del Valle Isla, 2021). This is largely benefited by the economically weaker sections and becomes one of the pathways that makes cities more livable, for humans as well as other species we coexist with (Sardeshpande et al., 2021). Several such cases exist where there is an outstanding mutual interdependence of humans and nature in which ecological gradients maintain the biodiversity and plays a fundamental role in shaping the modern cultural heritage of the society (Derkzen et al., 2017; Maurer et al., 2023; Tabarelli et al., 2017). Meanwhile the large-scale transformation of such ecosystems reduces their capacity to provide critical ecosystem services to local communities leaving such communities in respire leaving the whole social-ecological system vulnerable to various risks including climate change (Murphy et al., 2019; Santhanam & Majumdar, 2022; Tabarelli et al., 2017). Such situations can be avoided if the connections between the society and ecology is understood at a system level.

3.3 Social systems shaping ecology and ecological systems shaping the society

There is also a strong influence of social factors on the ecological factors of GI like the type of plants, their abundance, diversity, health and distribution pattern; this acts like potential biodiversity filters that when unutilised in GI planning can support long-term ecological resilience (Grilo et al., 2024). For example, the local availability of the saplings

of a plant species greatly influences weather that plant will be chosen for planting in that area (Torres-Camacho et al., 2017). Therefore, it is important to make sure that saplings of native and adaptive species are made available in the local nurseries so that GI will be resilient in their natural habitat. A species can have the power to both unite and divide around issues in social and ecological spheres where the personal relationships that community members have with the same species can significantly influence their attitudes and practices (McMillen et al., 2019). Meanwhile the geographical context is also an important factor of the social-ecological system. As the geography changes the species and their connection to the surroundings also changes. Meanwhile significant cultural changes can also be observed with a change in geography. Different GI elements perform differently in different contexts, depending as much on geographical and social context as physical characteristics and configurations (Dong et al., 2022; Staddon et al., 2018). Therefore, the comprehensive knowledge about ecological and social systems, as well as how they interact in space and time needs to be used for local and regional-level place-based planning to facilitate stewardship and land management to maintain functional networks of GI that provide ES (Angelstam & Elbakidze, 2017). Thus, GI can be planned to develop system resilience through adaptation and even transformation in facing climate change, food insecurity, and limited resources by providing ES such as plant biodiversity, food production, microclimate control, soil infiltration, carbon sequestration, visual quality, recreation, and social capital (Lovell & Taylor, 2013).

3.4 Collaborative approach

Collaborative approach is another aspect that is discussed under the SES approach towards GI. At the government level collaboration between different departments is needed for operationalizing the multifunctionality of GI which is important for SES resilience (Lennon et al., 2017). Also, the collaboration between planning organisations, institutions and the community help in in-depth understanding of SES to better plan and design GI (Finger-Stich, 2022; Gerlak & Zuniga-Teran, 2020). Ownership and agency many be distributed among various organisation and diverse communities to produce GI outcomes that reflect their social and cultural contexts (Herrmann et al., 2018; Ward et al., 2019). All these linkages between physical aspects and social aspects including communities, institutions and governing bodies are key to successful planning and design of GI (Andersson, 2018; Gerlak et al., 2022; Rastandeh & Jarchow, 2022).

It can be seen from above inferences that planning GI though the Social-Ecological System thinking allows for a holistic implementation where the policymakers and researchers are constantly aware of the dynamic relationship between GI and the social, economic, and political environments (Chien et al., 2022; Jones & Russo, 2024). In this manner the challenges on operationalising GI such as standards, regulation, socio-economic factors, finance and innovation can be tackled by working with the social, ecological and technical systems in urban environments for the continued process of mainstreaming GI for enhanced urban resilience (Staddon et al., 2018). Also, it is essential to consider social- ecological system while assessing existing GI for improved future decision making resulting in better implementation and maintenance of GI (Mosleh et al., 2023; Ward et al., 2019). Thus, when green infrastructure is operationalised through a social–ecological systems approach where, social and ecological dimensions of resilience traits are recognised leads to better urban resilience (Reynolds et al., 2022).

4. Conclusions and Recommendations

Through this literature review a deeper understanding of SES approach towards planning and implementation of GI in urban areas was achieved. The major themes that was found in the SES approach were community participation and knowledge sharing in planning and implementation of GI, the connection that economically weaker sections have with the ecosystems surrounding them, the relevance of understanding the influence of geographic and social settings on the ecosystem and interactions, and collaboration between various institutions, organisations and the community. From this analysis, it can be seen that when GI is implemented with a social-ecological systems approach, an overall better result can be achieved with higher resilience factors. This shows that a social-ecological systems approach in GI is essential for achieving the overall resilience of the society and ecology. Therefore, it is recommended that city authorities should focus on the social and ecological aspects like participatory approach and creating a sense of belonging and social responsibility, collaboration between organisations, context, ecological connections and nativity and adaptivity of species while planning for GI.

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ARTICLE

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Role of Women Community

Participatory Approach through Design

By Ar. Preethika K Sastha and Ar. Vivek Sholai Raja A

1. Introduction

The role of women in design engagement in the community is essential to creating inclusive and practical solutions that take into account the varied requirements of the community. The importance of women's responsibilities in design and community development has increased significantly. Their participation guarantees that initiatives consider the real-world requirements of different community members, including those about usability, safety, and accessibility. Throughout history, women have been integral to community life, frequently acting as the cornerstone of familial and social organisations. However, historically, they have been excluded from design processes and decision- making, particularly in community participatory models. These days, there is growing recognition of the critical role that women's perspectives and contributions play in these processes.

Engaging all stakeholders in the design process is essential to a collaborative and inclusive community participatory design strategy that guarantees effective and pertinent solutions. Women must shape outcomes that are equitable and sensitive to the many demands of communities because of their unique perspectives and experiences. By ensuring that design solutions meet the needs and goals of those engaged, their engagement helps close gaps between various community members. In addition to elevating women's perspectives, this approach promotes more environmentally friendly and culturally aware outcomes. Women's participation in design processes can result in creative solutions that would not have been thought of otherwise, advancing social justice and improving everyone in the community's quality of life.

In this context, examining how women engage in community participatory design in this setting sheds light on the potential for significant change that may result from their efforts. It highlights how inclusive design strategies that draw on the depth of community expertise and knowledge have the power to transform lives. Including the perspectives of women allows us to develop more complete and efficient design solutions that speak to and benefit entire communities. By actively incorporating women's perspectives into the planning process, communities can reap the benefits of more equitable and all-encompassing solutions. This participative approach empowers women and fosters collective ownership and collaboration by allowing them to participate in decision-making. In addition to empowering women by enabling them to participate in decision-making, this participatory method promotes a sense of communal ownership and teamwork. In the end, incorporating women's opinions into design procedures produces results that are more relevant, sustainable, and supportive of a broad range of community needs.

1.1 Aim and Objectives

Aim

This research explores the significant contributions of women's participation in design to community development, examining how their involvement shapes inclusive, responsive, and sustainable built environments that foster social cohesion and community well-being.

Objectives

- Empower women by providing opportunities for leadership, decision-making, and skill development through design activities.
- Provide training and development opportunities for women to build their skills in design, planning, and skilled knowledge.
- Develop design solutions that contribute to the sustainability and resilience of the community, with a focus on women's roles and needs.
- Enhance women's access to resources, information, and opportunities related to design and community development.

Study Area

The project discriminates a live study on architecture and women's involvement in community-engaged design conducted in Tamilnadu, Southern India is covered under the study. Primary research works, highlight community involvement across distinct sites in Tamilnadu using two case studies of Kuthambakkam and Chittarkottai villages, including field visits, were conducted in these two villages whereas data at the federal and state levels are gathered and assembled for analysis from secondary sources.

Scope of The Study:

The research will be focused and covered on the contribution of women's participation in design. To examine the plan and the policies that support women's communities. The area of the study will be done in the state of Tamilnadu in Southern India. Whereas women's communities engage and participate with stakeholders and others to facilitate the completion of projects. Women play a vital role with their active participation in community dialogue, meetings, seminars, workshops, awareness programs, and literacy.

Limitations of The Study:

Women's participation in design faces several limitations, including entrenched gender biases that can undermine their contributions and influence. Women often encounter systemic barriers such as limited access to resources, training, and decision-making platforms, which can restrict their ability to actively engage and lead in design processes. Additionally, cultural and societal norms may diminish their roles or perceptions in design-related activities. These challenges collectively hinder the full potential of women's participation and the incorporation of diverse perspectives in community design projects.

2. Literature Review

Much research done in the realm of community involvement has demonstrated the importance of women's perspectives on habitat development in design. The goal of research is to comprehend how women have participated in the development of community, particularly in emerging nations. Additionally, several researches have been conducted to comprehend how the tangible and intangible components of the built environment interact. A framework and methodology for the research were developed by reviewing the literature on women's challenges, needs, and community involvement in design.

2.1 Community Participation

Raina (2023) has stated that after a thorough review of the literature, two important conclusions emerged. First and foremost, inclusive and sustainable built environments depend on community participation to be created and maintained. Second, for such projects to succeed, there must be a strong sense of community ownership. It was argued that including the neighborhood in decision- making processes can result in an environment that is socially and environmentally responsible. The study's findings suggest that community members need to be involved in the planning, designing, and managing of their built environment to achieve more sustainable and inclusive outcomes.

2.2 Women's involvement in Design

Gbenga et al. (2023) conducted a study that adds to the body of research on women's involvement in the construction sector. Leaders in the industry, educators, and legislators will be impacted by the study. To ensure that the construction industry adopts gender-neutral practices, removes discriminatory barriers, and establishes supporting frameworks, policy changes are necessary. Institutions of higher learning must modify their curricula to actively seek out and develop women's potential in engineering and construction. In response, companies ought to put into place doable strategies like customised health and safety procedures, mentorship initiatives, and adjustable work schedules to improve the hiring, retaining, and advancement of women employees in the construction industry.

Jenifer. A.M. & Velmurugan (2022) assessed women's participation in a variety of roles and activities in post-conflict contexts, including those of breadwinners and others. In this study, women's involvement in social, family, economic, and political spheres is examined in light of their ability to effect

change and actively engage in their roles. In addition, ethnicity, tribal strife, and the authority to rule and hold property are discussed. The seven principal functions that women play in the post-conflict phase are women as victims of sexual abuse, women as combatants, women for peace in non - governmental sector, women in formal peace politics, women as coping and surviving actors, women as household heads, women in formal and informal employment opportunities.

Nguluma & Eliufoo (2019) two cities were chosen for in-depth case studies: Dodoma and Dar es Salaam. The selection of Dar es Salaam was based on its position as Tanzania's major city and the volume of construction activity in the area. Because of this and the nature of the jobs they are given, male employees typically make more money than their women counterparts. However, because they are more likely to work in lower-paying positions, women construction workers frequently earn less money. The study also brought attention to the difficulties that are unique to gender on building sites. For instance, in the study's focus group, women deal with challenges including sexual harassment, poorer job satisfaction, and health issues brought on by juggling work and home obligations, and employment uncertainty.

These results emphasise the value of including community people in the planning process and show how community involvement may promote inclusive and sustainable built environments.

3. Methodology

Figure 1 shows the methodology adopted.

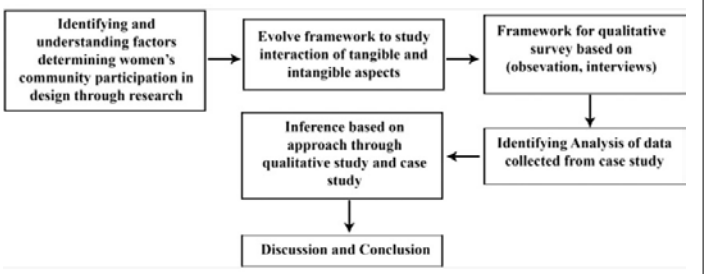

Figure 1: Research Methodology
Source: Author

4. Data Analysis and Finding

This study intends to initiate policy dialogues on the status of women workers in the construction sector.

In Mumbai, 3000 women from Odisha and Maharashtra will receive training in skill development as part of Habitat for Humanity India's Project Nirmanshree. Through improved access to housing-related services and rights as well as the creation of economic opportunities, Project Nirmanshree, funded by the European Union, seeks to empower women.

The goal of Nirmanshree is to give women access to the habitat development industry. Our job is to help people develop their technical and entrepreneurial skills so they can connect with the market and other social rights that will help them manage profitable businesses. This intervention is well-timed. The post-pandemic economic recovery would be greatly aided

Figure 2: Women trained in technical and entrepreneurial skills under project Nirmanshree
Source: project Nirmanshree

	Male	Female	Total	Male	Female	Total	Male	Female	Total
	India			Odisha			Maharashtra		
Rural	15.55	5.87	12.44	25.33	14.15	21.82	7.37	1.14	5.14
Urban	13.1	4.4	11.1	16.75	16.55	16.7	10.98	2.93	8.99
Rural + Urban	14.85	5.57	12.8	24.04	14.41	21.12	8.74	1.61	6.46

Figure 3: Percentage of Gender Segregated Construction Workers
Source: Periodic Labour Force Survey 2010-21, MoSPI

by the entry of these skilled female masons into the construction industry, according to Dr.Rajan Samuel, Managing Director of Habitat for Humanity India.

Trainers certified by the Construction Skill Development Council of India (CSDCI) deliver theory-based and practical training. Following completion, the applicants go through an independent evaluation to receive certification from Skill India and the National Skill Development Corporation (NSDC).

With the qualification, women will be able to work as masons, apply for loans, and launch their small enterprises. Additionally, they can register with the Building and Other Construction Workers' Benefit Boards to participate in the benefit programs that each state's board offers.

In the first project, a crew of all women are working on every facet of building the house. The 20- person team is responsible for all aspects of construction, including designing the layout and budget, laying the foundation, constructing the walls, pouring concrete, painting, and other jobs. Sheeba reports that since work started, the organisation has received additional bids. "The project is now a huge success, and the house's construction will soon be finished. The group already has the chance to build another house. According to Sheeba, the panchayat will provide opportunities for the construction of additional dwellings under the state government's "Life Mission" and "Ashraya" projects.

OVERVIEW OF CASE STUDIES

Figure 4 shows the location of Case Studies

Figure 4: Map showing of the location (left) Kuthambakkam and (right) Chittarkottai
Source: Author

1. CASE STUDY 1 : Kuthambakkam Village (Thiruvallur Dist)

R Elango who constructed 50 twin homes in a single community named "Samathuvapuram" (Place for Equality) in 2000, for the first time in India. There was a Dalit and a non-dalit resident in each twin home. Later, the Tamil Nadu government accepted this plan and made it available to the whole state. Caste conflicts were a constant problem in his village, Kuthambakkam, which had seven hamlets and a population that was over 50% Dalit.

In Kuthambakkam village, 150 dwelling units have been finished, and 100 more are part of the Sumathuvapuram project (completed in 2005). There are 286 square feet of housing for every residential unit. Each plot area is five cents, and the site is about fourteen acres in size. Two large central open spaces with independent access from the main entry are the focus of the linear site arrangement. There are agricultural lands all around the location.

A network may have between 15 and 20 villages with 50,000–60,000 people living in them. 40 products are consumed on average in a village such as grains,

rice, dhal, oil, baked goods, veggies, clothing, detergents, and soaps, etc., These consumables are worth Rs. 55 million 60 million each month. Women are more involved in this hamlet than men and they also contribute to constructing every building made by women's community.

Figure 5: Livelihood initiatives of women at Kuthambakkam
Source: Kuthambakkam Model

The village is distinguished by its unique panchayat, small-scale industries, and high-quality infrastructure. Panchayat (village council) officials from all around the state gather at the academy to exchange expertise and experience. The village's inhabitants' health and well-being have significantly improved because of the creative rural housing and habitat development project in Kuthambakkam. They are more self-assured, possess superior talents that open up career options and are better integrated into society. The village of Kuthambakkam has emerged as a regional model village. Panchayat leaders have learned from the experience and are considering adopting the strategy in other areas.

2. CASE STUDY 2: Chittarkottai Village (Ramanathapuram Dist)

Chittarkottai is a Panchayat in Ramanathapuram district, Tamil Nadu, India where around 2000 people are living. It is made up of seven settlements with a diverse population of religious beliefs. This Samathuvapuram was constructed in the year 2002 by the user. The majority of those who practice Islam and Hinduism. Remaining individuals who practice Christianity. The Bay of Bengal and the shoreline together. People's livelihoods are derived from farming, fishing, and harvesting.

In Chittarkottai village, there were about 100 dwelling units in Sumathuvapuram. There are 180 square feet of housing for every residential unit. Each plot area is five cents, and the site is about eight acres in size. Open spaces with independent access from the main entry are the focus of the linear site arrangement. The site carries Uppalam land. The land is located closer to the sea. There were agricultural lands all around the location.

In this village, people were facing financial difficulties, which had a significant impact on the villagers. Gathering spaces and communal spaces are not effectively used and maintained. The library has been retained as a crucial component of the master plan, but not in the function many public buildings are disparate in conditions due to no community participation.

5. Results and Discussion

Women's participation in design has emerged as a critical factor in achieving inclusive and sustainable community development. By involving women in the design process, communities benefit from diverse perspectives that address a wide range of needs and preferences. This section presents the results and discussions based on various studies, case studies, and practical insights into the impact of women's participation in design.

Community engagement:

Community engagement in design refers to the process of involving community members, stakeholders, and users in the design decision-making process. It aims to create designs that are responsive to community needs, values, and aspirations. The benefits of community involvement in design include improved social cohesiveness and community interactions, more inclusive and responsive designs, and increased community ownership and acceptance. By engaging community involvement in the design process, villagers can create solutions that are more effective, sustainable, and equitable.

Participatory design:

Participatory design through women's community involvement in construction projects emphasises the inclusion of women's perspectives and needs in the planning, design, and implementation phases. This approach ensures that construction projects, whether they are buildings, public spaces, or infrastructure, are more attuned to the realities and aspirations of women in the community. Involving women's communities in design participation not only leads to more effective and inclusive solutions but also empowers women by giving them a voice in shaping their environments. This collaborative

approach fosters greater community ownership and ensures that designs are truly responsive to the needs of the women who will use them.

Enhancing social equity:

The idea of social equity refers to the fairness and justice of allocating resources, opportunities, and treatment among various social groups. Enhancing social equity within a settlement requires a multifaceted approach that addresses systemic disparities and actively involves all community members in shaping their environment. By prioritising inclusivity, fairness, and responsive planning, settlements can become more equitable and supportive places for everyone.

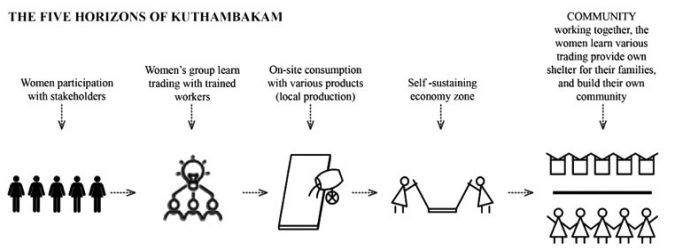

Figure 6: Sequential participation of women's community at Kuthambakkam village
Source: Author

Figure 7: Map showing of the location Chittarkottai
Source: Author

Community empowerment:

Empowering women in a village setting involves creating opportunities and support structures that enhance their roles, responsibilities, and rights within the community. This approach fosters gender equality and ensures that women have the resources and platforms they need to contribute fully to their communities. By assessing needs and strengths, promoting education and skill development, providing economic opportunities, engaging in community development, and building to support their network communities, they can create a more inclusive and equitable environment for all members.

Self-sustaining village:

Creating a self-sustaining village involves a holistic approach that integrates environmental, economic, and social aspects. By focusing on sustainability, local resource use, and community empowerment, a self-sustaining village can thrive and serve as a model for resilient and equitable living. First, community engagement significantly enhances the relevance and functionality of architectural designs. By involving residents in the design process, solutions become more tailored to the specific needs and cultural practices of the community, leading to practical and user-friendly outcomes. Furthermore, such participation often results in more sustainable practices, as local knowledge and materials are utilised, which reduces environmental impact and supports the local economy. Community-driven designs frequently incorporate innovative, site-specific solutions for energy efficiency and resource management, such as renewable energy systems and water conservation techniques. Additionally, this approach fosters stronger social cohesion and a sense of ownership among residents, which enhances the community's ability to maintain and adapt the village over time. However, balancing diverse perspectives and ensuring ongoing engagement can be challenging. Overall, research highlights that integrating community input not only improves architectural and environmental outcomes but also promotes long-term sustainability and resilience.

Women's participation in design significantly enhances community development by ensuring that diverse needs are addressed and promoting inclusive, user-centered design. While challenges remain, such as institutional barriers and cultural norms, the benefits of involving women in the design process ranging from improved design outcomes and community engagement to economic empowerment demonstrate the importance of fostering gender inclusive practices. By addressing these challenges and supporting women's participation, communities can achieve more equitable and effective development outcomes.

6. Conclusions and Recommendations

The study concludes by highlighting the significant influence that community involvement has on women involved in the design process. Participation from women adds insightful viewpoints that improve design projects' sustainability, usability, and inclusivity. Their involvement guarantees that designs better represent the many requirements and goals of the community, creating settings that enhance social cohesiveness and general well-being. The two case studies listed above show how women's participation in the community enhances social circumstances, the economy, infrastructure, and other facets of village life. A prosperous hamlet,

Kuthambakkam, is an example due to the ongoing involvement of women in the community. The study shows that women's active participation improves community ownership and empowerment, as well as the effectiveness and relevance of design solutions. It is crucial to put policies in place that support and promote women's involvement to fully reap these benefits. Some of these policies include meeting participation obstacles, giving training opportunities, and creating accessible forums for women to voice their opinions. Adopting an inclusive participatory strategy that involves women benefits the design process as well as creating more dynamic and egalitarian communities, which opens the door to more sustainable and responsive development solutions.

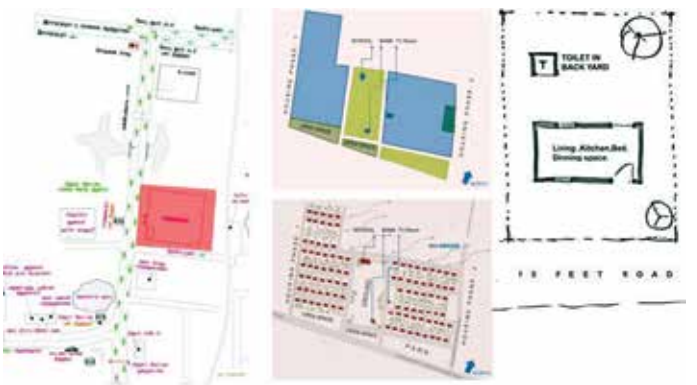

Figure 8: Chittarkottai
Source: www.chittarkottai.com

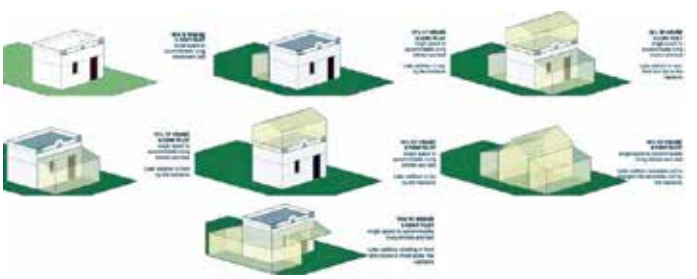

Figure 9: Later additions on their dwellings made by inhabitants
Source: Author

Figure 10: Additions made by individuals there is no community involvement
Source: Author

To improve women's community participation in design, a multimodal strategy that tackles current obstacles and fosters meaningful engagement must be implemented. To begin with, it is crucial to actively include women from a variety of backgrounds, particularly marginalised groups, to ensure full representation. This will help to capture a wide range of needs and viewpoints. More equitable involvement can be facilitated by removing practical obstacles to participation, such as offering flexible scheduling, accessible locations, and assistance with childcare or transportation. Furthermore, it's critical to go past tokenistic methods by empowering women to make actual decisions and encouraging intense, cooperative participation through the design process. The efficacy of women's contributions can be assessed and enhanced by establishing precise measures for tracking long-term results and assessing the influence of their engagement. Finally, to maintain participation's effectiveness and responsiveness to community needs, it will be necessary to continuously solicit feedback from female participants and modify techniques in response to their suggestions. Communities may better utilise women's contributions by putting these suggestions into practice, which will provide more creative, inclusive, and sustainable design solutions.

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Preethika K is an architect and educator with expertise in urban design and vernacular practices. With over four years of teaching and professional experience, she is passionate about research, design innovation, and fostering student growth. She holds an M.Arch in Urban Design from BMS School of Architecture.
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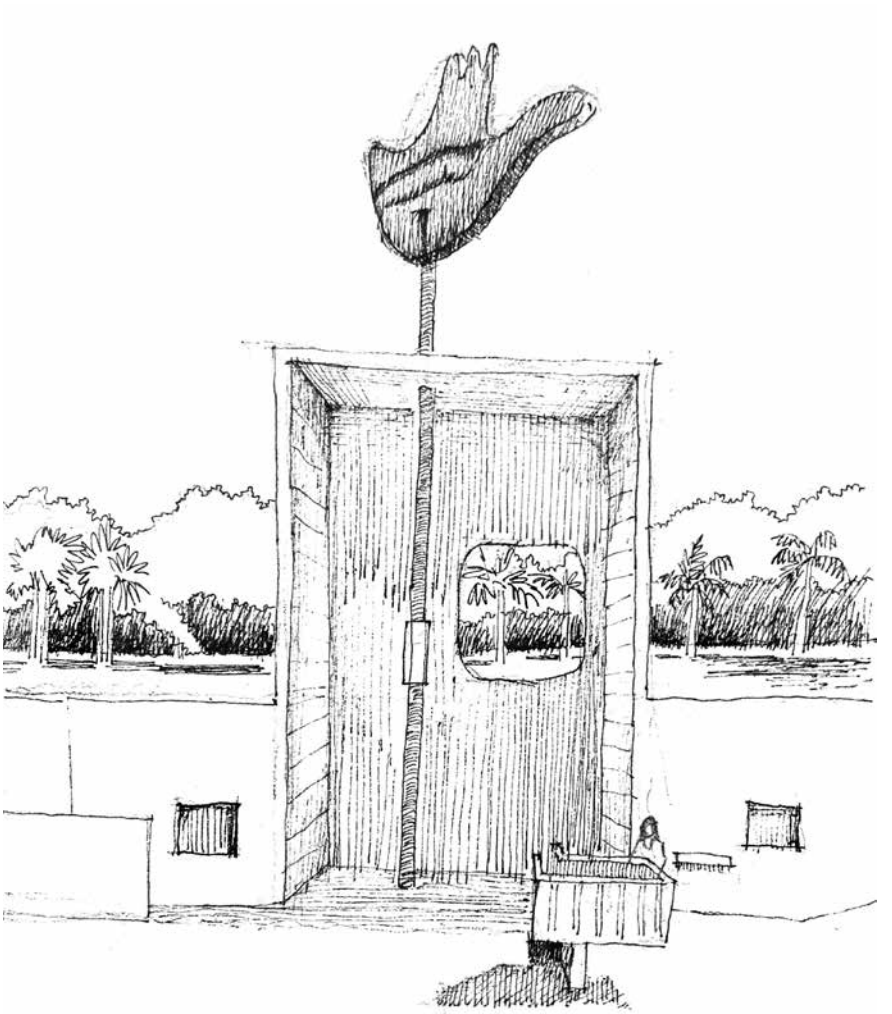
SKETCHES

A Journey in Lines

Capturing India's Urban and Historic Landscapes

By Sandesh Jadhav

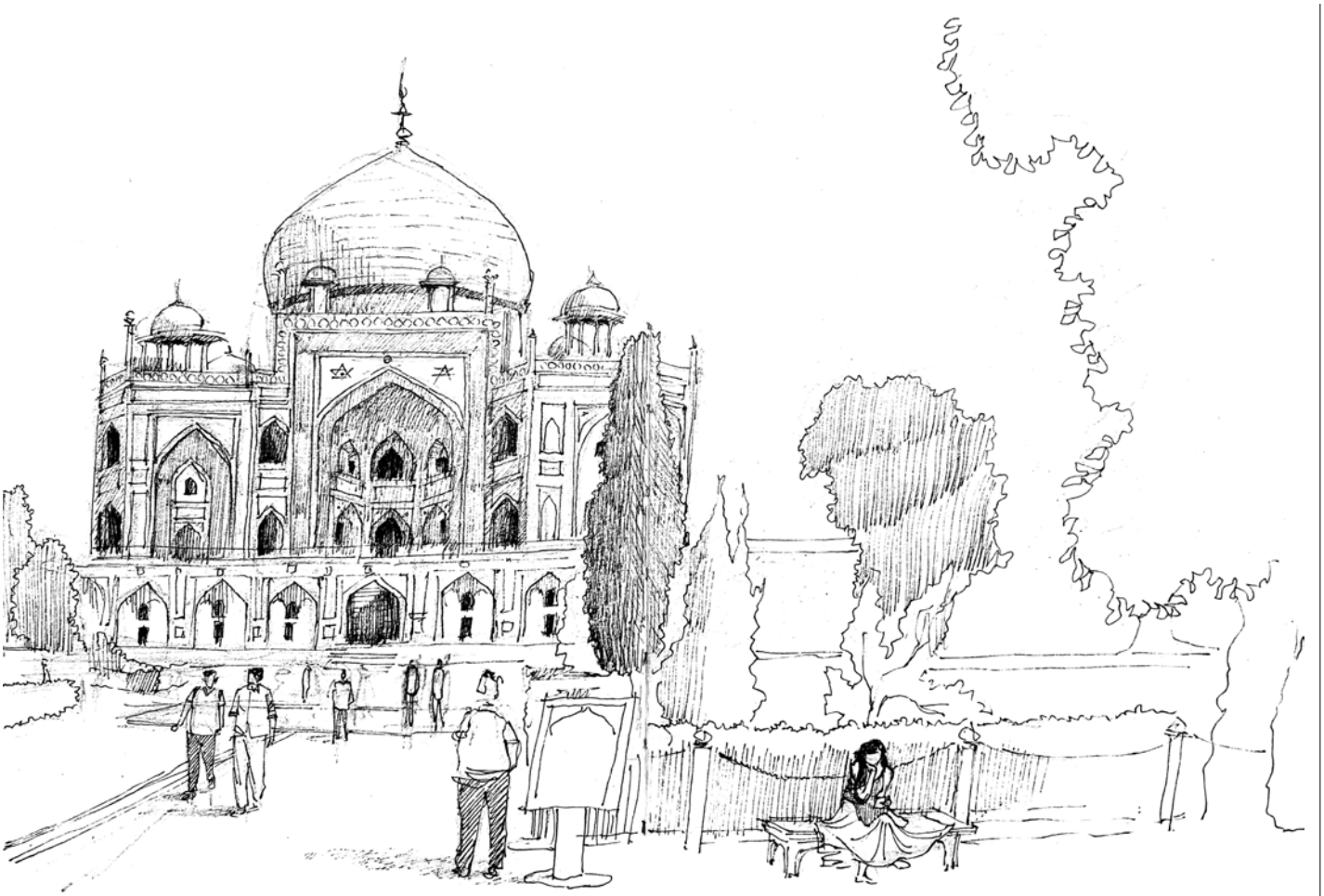
From the timeless grandeur of Mughal monuments to the ever-moving pulse of Mumbai's streets, my sketching journey has been a layered exploration of architecture, culture, and fleeting urban moments. Each stroke; intentional or impulsive has been a reflection of not just what stood before me, but how I felt within those spaces. This particular set has been rendered in the medium of fine liners and markers in the duration of 2023 – 2025.



One Hand Monument, Chandigarh

Date: 2 Oct 2023 | Duration: 45 mins | Medium: Fine liners

The One Hand Monument in Chandigarh's Capitol Complex; This iconic creation by Le Corbusier was an unforgettable visual experience during our college study tour. The play of bold concrete masses and pressure of structural lines deeply fascinated me. I felt compelled to capture the monument not just as a structure, but as a complete form echoing the architect's vision.



Humayun's Tomb and Love!

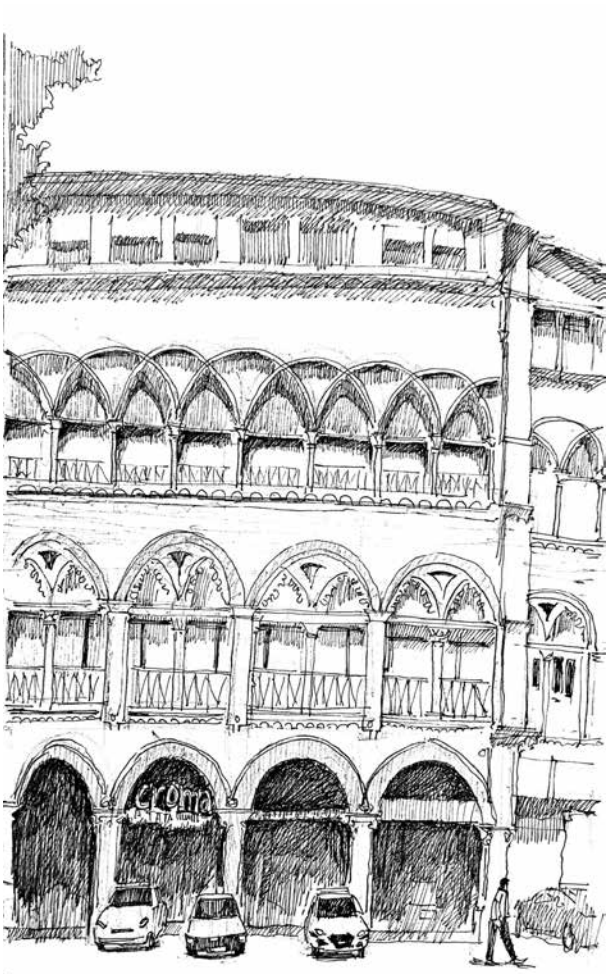
Date: 5 Oct 2024 | Duration: 90 mins | Medium: Fine liners & Marker

Sketching Humayun's Tomb was both a challenge and a delight. Framing the symmetrical beauty of this Mughal masterpiece in perspective required precision, while the act of finding a peaceful spot amidst dense tree cover added to the adventure. Life surrounding the monument was as captivating as the tomb itself; This work became an ode not just to architecture, but to the living energy around it.

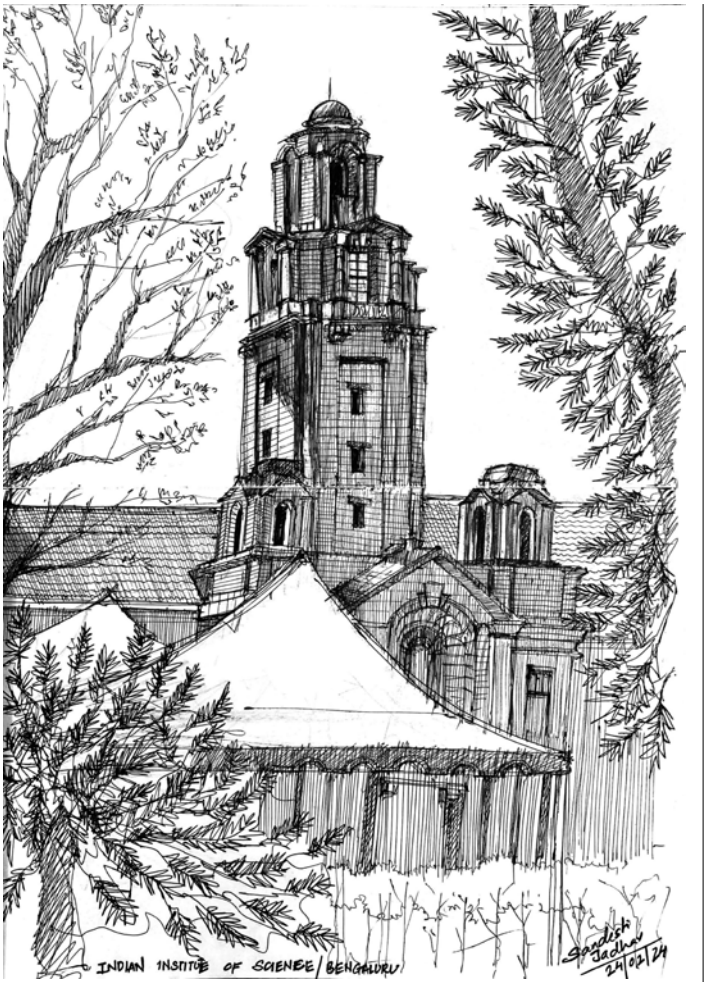
Jodhabai Mahal, Fatehpur Sikri

Date: 29 Sept 2024 | Duration: 60 mins | Medium: Fine liners & Marker

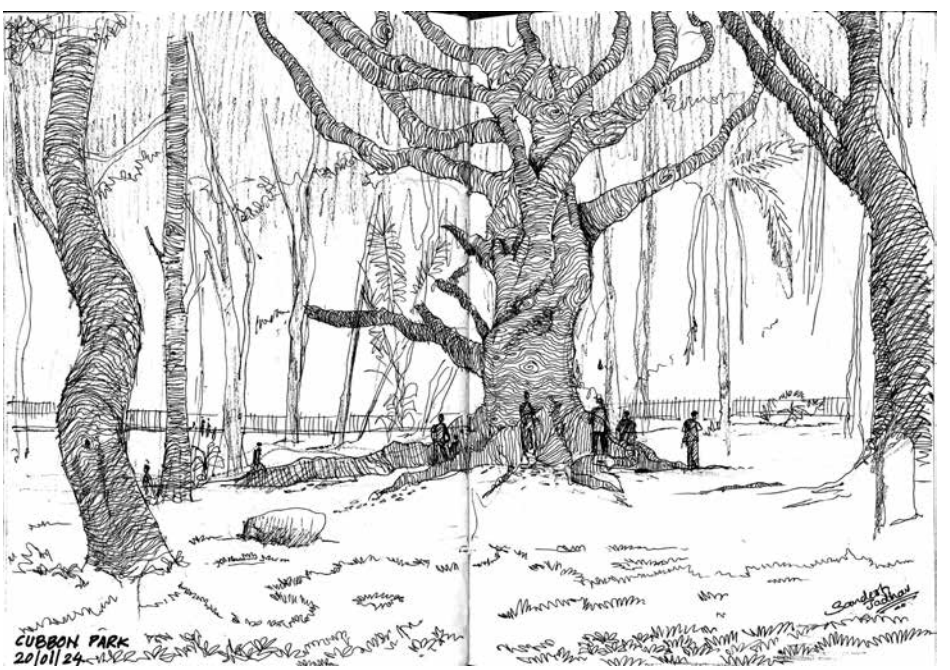
This was a sketch that came alive with character. Jodhabai Mahal, with its ornate Jharokhas and intricately ventilated spaces, tells the story of a royal life rooted in climate-conscious design. The composition, highlighted by a prominent chhatri, effectively captured the architectural depth and cultural grace of the era.



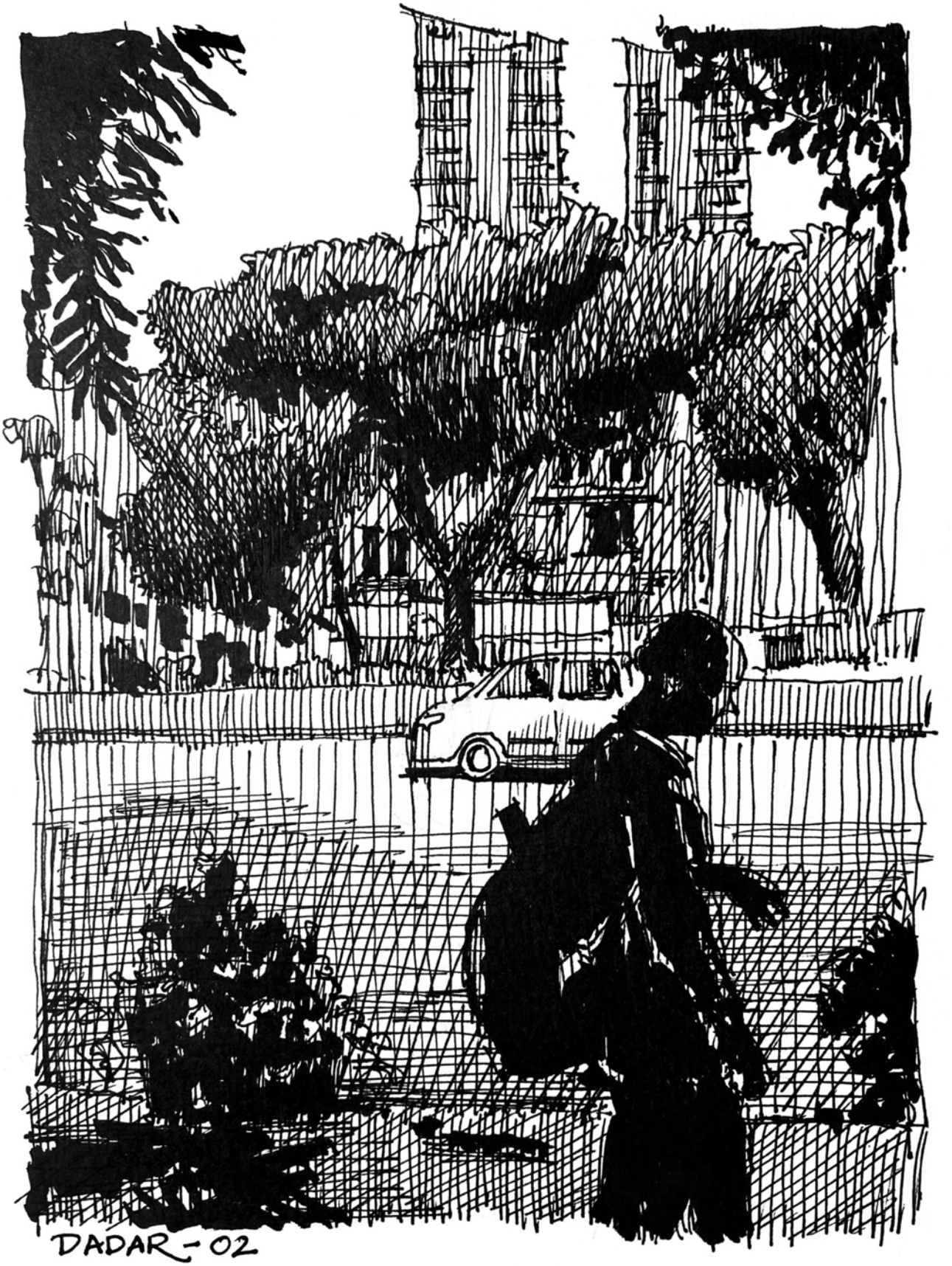
Horniman Circle, Mumbai
Date: 4 May 2025 | Duration: 90 mins | Medium: Fine liners
On a vibrant Sunday morning, the Urban Sketchers collective met at Horniman Circle for a collaborative sketch walk. My focus was on the Victorian-era architecture of South Bombay, capturing its perfect symmetry and sense of verticality. The surrounding movement of cars and pedestrians offered a compelling contrast in scale, grounding the structure in its dynamic urban context.



Indian Institute of Science (IISC), Bangalore
Date: 24 Feb 2024 | Duration: 120 mins | Medium: Fine liners
The OPEN DAY at IISc was a hub of innovation and enthusiasm. Amidst tech exhibits and bustling flea stalls, I found a perfect frame to sketch this iconic academic structure. The trees partially interrupting the architecture added depth and interest to the composition, while fine hatching brought out its layered elevation with nuance.



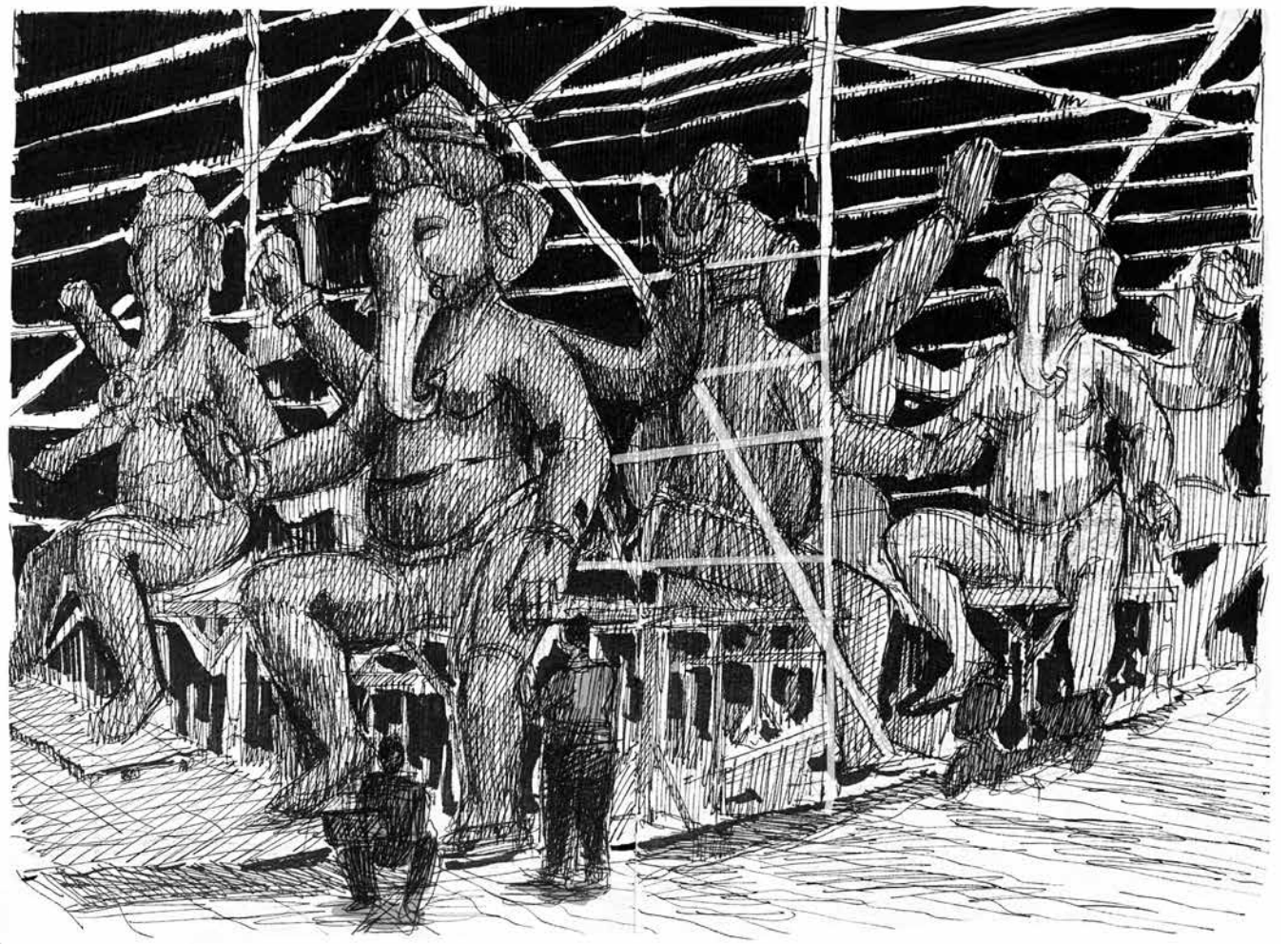
Cubbon Park, Bangalore
Date: 20 Jan 2024 | Duration: 120 mins | Medium: Fine liners
Cubbon Park's majestic trees dominate the skyline, speaking of a deep-rooted relationship between nature and the city. This sketch focused on portraying that very bond; Between tree and human, permanence and motion. Fine lines were layered delicately to create organic textures, making the tree itself a narrative centre-piece.



Dadar Streets, Mumbai

Date: 20 June 2025 | Duration: 45 mins | Medium: Fine liners

Each morning on my commute, I pass a busy Dadar junction where human movement feels almost rhythmic. This sketch attempts to freeze that fleeting energy; The organized chaos of Mumbai mornings. Bold black strokes and vertical lines suggest depth, while shadow and light are expressed through the absence of ink, reflecting the ephemeral nature of city life.



Parel Workshop, Mumbai

Date: 29 June 2025 | Duration: 120 mins | Medium: Fine liners & Marker

My first encounter with the Parel Workshop was nothing short of magical. A place where colossal Ganpati idols are sculpted year-round, it radiates an energy of devotion and creativity. The most challenging aspect was interpreting the scale; The massive idols in relation to the surrounding bamboo structures and human figures. Light and shadow played a crucial role, with bamboo scaffolding forming dramatic foregrounds and receding layers.

Closing Thoughts

Each sketch in this journey reflects more than architecture; It reflects time, weather, human presence, and my own mood at that moment. With every new location, the paper becomes a stage where structure meets emotion. Through this collection, I hope to not only document spaces but also celebrate the quiet dialogue between people and the built environment they inhabit.

Sandesh Jadhav, a student of Rachana Sansad's Academy of Architecture (2020 – 2025), is passionate about illustration and urban sketching. With 7 years of experience in urban sketching, he crafts detailed, monochrome artworks and cartoons with bold strokes. As a Junior Architect, he applies his sketching skills to innovative landscape and urban design solutions, blending art and architecture.

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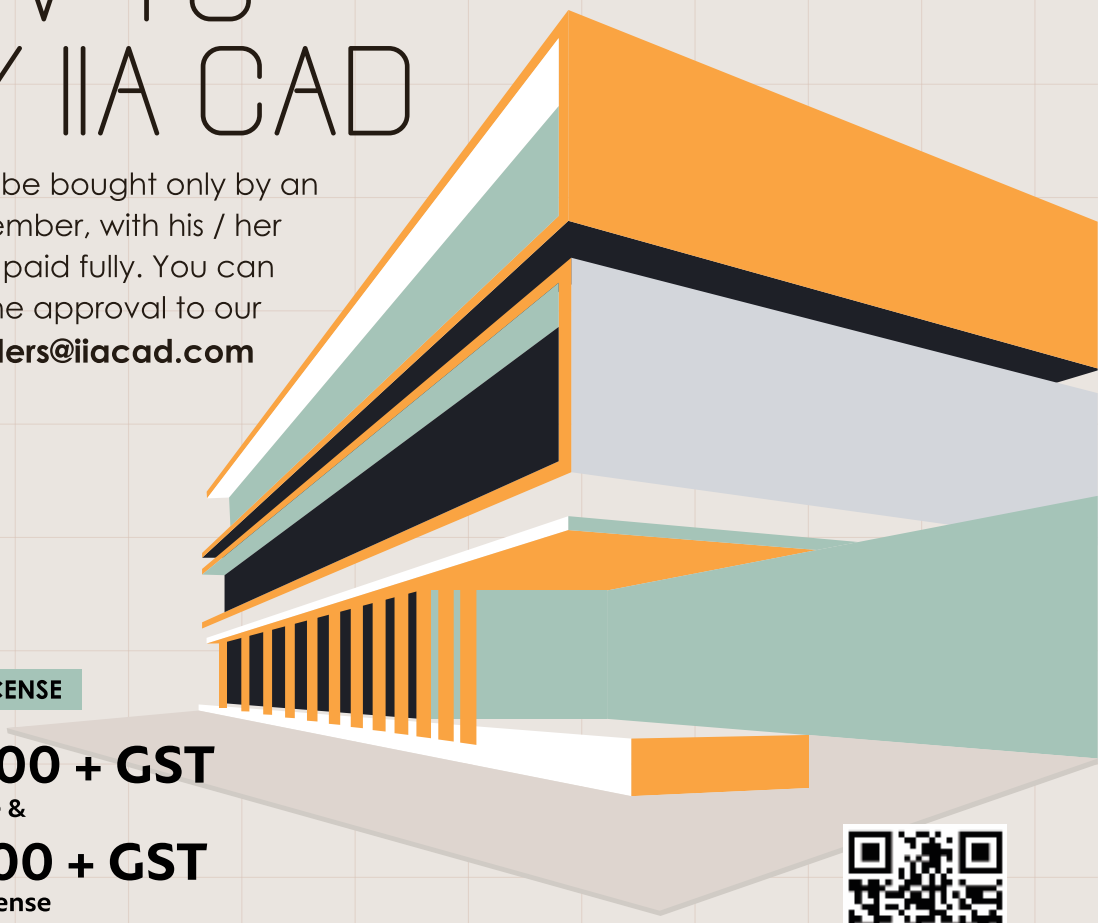

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