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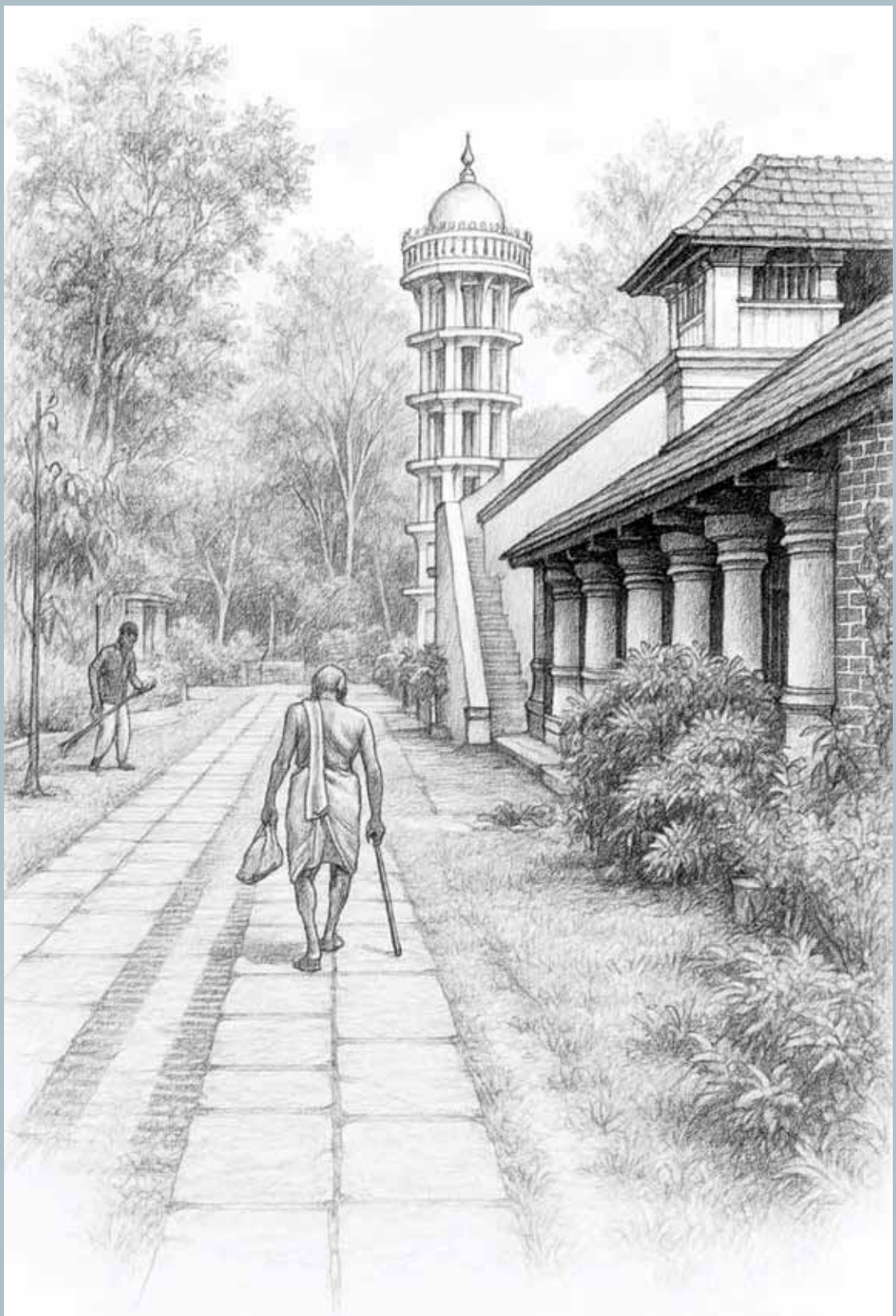

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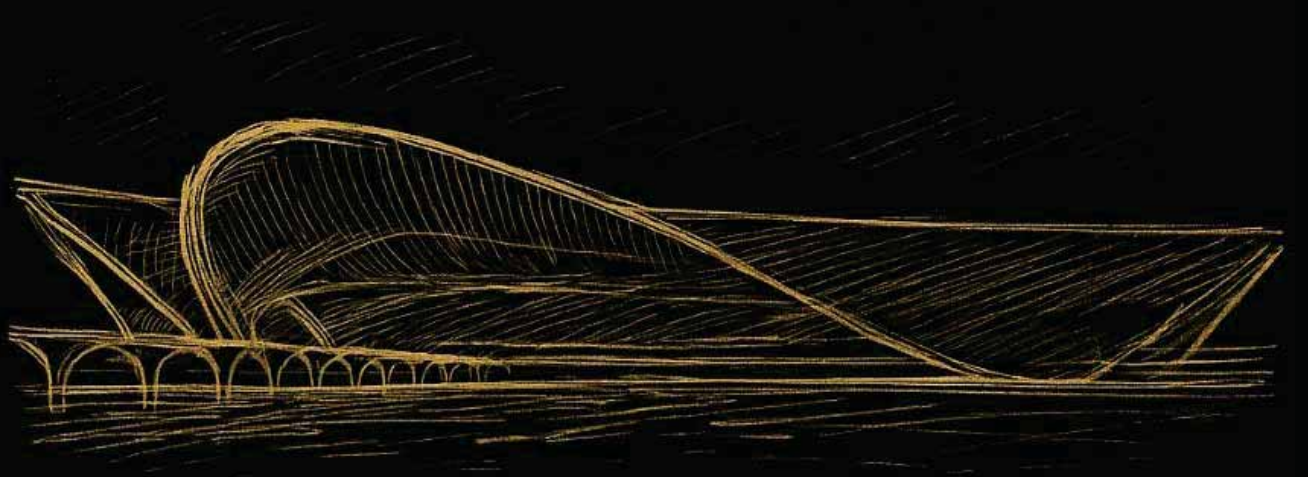

BUILDING FOR THE FUTURE

OCTOBER 7

THE INDIAN INSTITUTE OF ARCHITECTS

CONTENTS

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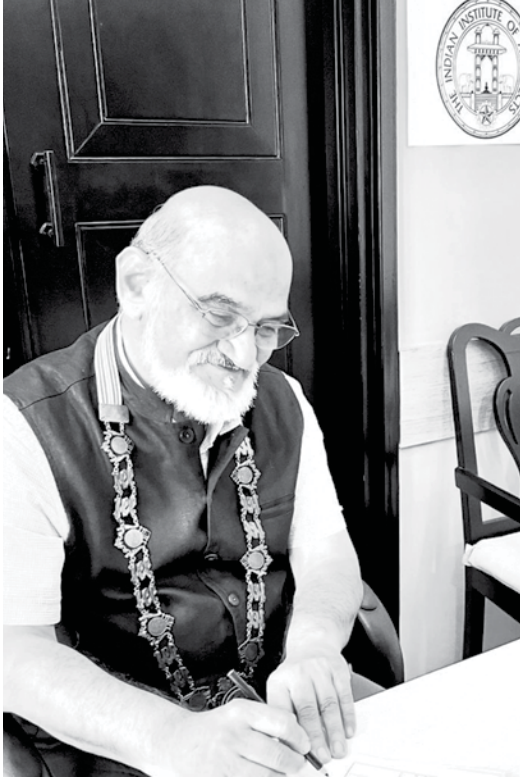
PRESIDENT'S MESSAGE



Namaskar to all IIA members.

As we present the September issue of the *Journal of the Indian Institute of Architects*, we find ourselves at a defining moment for our profession, one that embodies both reflection and renewal. The coming month of October brings with it the celebration of *World Architecture Day*, when architects around the world unite to endorse our shared responsibility to shape a sustainable and equitable future through design. This year's theme, *"Building for the Future,"* deeply aligns with India's own architectural journey, a continuous pursuit of harmony between tradition and innovation, and between progress and purpose.

In this spirit of renewal, I am delighted to announce the **launch of the refurbished IIA website**, designed to serve as a dynamic and inclusive platform for our members. The new interface enhances accessibility, connectivity, and professional exchange, reaffirming IIA's commitment to being a forward-looking institution that evolves with its members and the times.

Equally significant is the milestone we have recently achieved on the international stage; the **signing of the agreement with the International Union of Architects (UIA)** to host the **UIA Forum 2027 in India**. This event will bring global architects, thinkers, and institutions together on Indian soil, marking a historic opportunity to showcase the depth and diversity of Indian architecture while engaging in meaningful global dialogue.

As we approach *World Architecture Day* in October, I invite every member of our fraternity to participate in the programmes, discussions, and celebrations being organised by IIA chapters and centres nationwide. Let this be a time not only to celebrate architecture but also to reaffirm our shared vision of building responsibly, inclusively, and with imagination for generations to come.

Ar. Vilas Avachat
President, The Indian Institute of Architects

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EDITOR'S NOTE

Greetings to all IIA members from the JIIA

As we step into the last quarter of 2025, architecture in India stands at a pivotal juncture, caught between the accelerating demands of urban expansion and the pressing need for sustainable and inclusive design. The pace of change around us, driven by technological, environmental, and social forces, calls upon our profession to not only respond but to lead with clarity and conviction.

Across the country, architects are re-examining what it means to build responsibly. Whether in the revival of vernacular wisdom, the adaptive reuse of existing structures, or the integration of AI and digital fabrication into design processes, the conversation is shifting from novelty to necessity. The climate crisis is no longer an abstract concern; it is shaping briefs, budgets, and building codes. The question before us is not whether architecture can adapt, but how swiftly and sensitively we can do so.

The September issue of the JIIA continues to explore this evolving terrain. It brings together diverse voices, academicians, practitioners, and students who reflect on the architect's role as both designer and citizen. Their essays remind us that architecture is a social act. It cannot exist in isolation from the communities it serves or the ecosystems it alters.

This moment also calls for renewed engagement within our own professional community. The IIA's ongoing initiatives in continuing education, urban research, and outreach to schools and young architects reflect a growing awareness that the strength of our discipline lies in dialogue. We must nurture mentorship, foster collaboration, and open more platforms for critical exchange within offices, institutions, and the public realm.

As we prepare for the upcoming ARCASIA and UIA forum, let us celebrate not only aesthetic achievement but also ethical intent. The projects that will define India's architectural future are those that balance ambition with empathy, projects that are as much about people as they are about form.

In a time of flux, architecture remains our means of continuity of connecting heritage with innovation, and human need with environmental responsibility. The task before us is immense, but so is the opportunity.

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

Vijayadurga Temple, Keri, Goa

By Ar. Vivek Korlekar

Shri Vijayadurga Temple, built in 1560, stands in Keri, North Goa, about 30 km from Panaji, the state capital. Located in Ponda Taluka, the temple is an excellent example of classical Goan architecture. Its walls and interiors showcase the traditional Kavi art form, known for its intricate designs and natural charm. The temple's serene surroundings create a peaceful atmosphere, making it an ideal place for worship and reflection. Rich in history and artistry, Shri Vijayadurga Temple remains a treasured symbol of Goa's cultural and spiritual heritage, attracting devotees and visitors who seek tranquility and devotion in its sacred environment.

This sketch of the Shri Vijayadurga Temple at Keri, Goa, beautifully portrays the temple's serene ambience and distinctive architectural charm. The artist skilfully captures the pathway leading toward the sacred structure, bordered by lush greenery and elegant colonnades that emphasize the harmony between nature and architecture. In the background, the tall, multi-tiered *deep-stambh* (lamp tower) stands as a symbol of divine light and enduring tradition. A solitary devotee walking along the path adds depth and a spiritual touch, representing faith, peace, and introspection. Through careful composition and delicate detailing, the sketch conveys the tranquil beauty of the temple complex while celebrating the cultural richness and artistic grace that define Goan temple architecture, inviting viewers to reflect on the sacred serenity it embodies.

Ar. Vivek Korlekar (A- 28348) is an Associate Professor at IES's College of Architecture, Mumbai. He holds a B.Arch. degree from the Academy of Architecture, Mumbai, 2012 and an M Arch in Urban and Regional Planning. He is inclined toward teaching the technical aspects associated with the architectural built form and likes to explore unexplored places as a traveller. He has also contributed as a speaker in the COA Teachers Training Programme 'Understanding Temples'. He is a doctoral scholar at the Lovely Professional University, Punjab.
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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

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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).

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(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

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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.

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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 Projected Future

Improving Safety along the Railway Tracks in Sub-Urban areas for Goods Train through Advanced Technology and Design Solutions

By Ar. Kumar Rahul Verma and Dr. Neeraja Lugani Sethi

ABSTRACT:
This paper focuses on enhancing the security of goods trains in suburban regions, a critical area often overlooked in railway security measures. The majority of crimes related to goods trains occur in these regions, underscoring the urgent need for improved safety measures. The study identifies several gaps in existing safety provisions, such as the lack of Crime Prevention Through Environmental Design (CPTED) guidelines for these areas and the absence of data related to freight/goods trains. The research employs a mixed-method approach to examine and identify the crime rate and types of crimes. It evaluates detection and control methods with an emphasis on both human intervention and technology intervention, specifically AI and IoT. The study also analyses the applicability of advanced technologies and CPTED guidelines for preventing crime along railway tracks, particularly in the context of goods trains in suburban areas. It scrutinises the RPF guidelines and SOPs for marshalling yards, goods sheds & freight terminals and identifies existing gaps. The paper proposes the use of advanced technologies such as Artificial Neural Networks (ANN) in conjunction with CPTED guidelines for crime reporting and mitigation. These technologies and guidelines are capable of identifying patterns and predicting potential threats, thereby enabling proactive measures to enhance the safety of goods trains. In conclusion, the paper advocates for the integration of advanced technology, innovative design solutions and CPTED principles to improve the safety of goods trains in suburban areas, contributing to the efficiency and reliability of railway transportation systems. It emphasises the need to address specific challenges in crime prevention along railway tracks in suburban areas and how technology can address these challenges. The paper underscores the potential of technology and design solutions in transforming railway security in suburban regions.

KEYWORDS: Crime Prevention, CPTED, Artificial Intelligence, Advanced Technology, Design Solutions

1. INTRODUCTION

India, with one of the largest railway networks (68,160 km) in the world, primarily consists of Broad Gauge (63,949 km), Metre Gauge (2,402 km) and Narrow Gauge (1,809 km). The fleet includes over 14,800 locomotives, with 4,543 diesel, 10,238 electric and 39 steam engines. It also has around 84,863 passenger coaches and 365,491 freight wagons. Each day, Indian Railways transports about 23 million passengers and handles approximately 4.1 million tonnes of freight (Figure 1).

The Indian Railways has a hierarchy of land use along the railway tracks ranging from residential to agricultural. These areas often face challenges related to safety and crime prevention. The need for research in these areas, particularly in suburban regions, is driven by several factors (Figure 2).

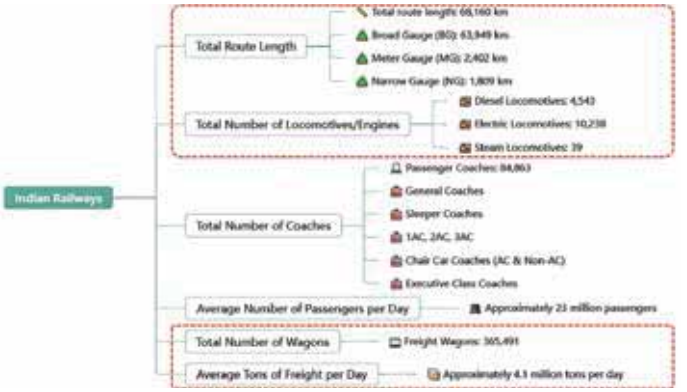

Figure 1: Baseline information about Indian Railway's Infrastructure with highlighted Freight Trains information.
Source: Year Book 2021-22, Directorate of Statistics and Economics, Ministry of Railways (Railway Board), Government of India, New Delhi

Figure 2: Factors driving the need for research in stretches ranging from residential to agricultural, particularly in the sub-urban areas
Source: Author

The research explores the application of advanced technology and design solutions to enhance safety and reduce crime along railway tracks in suburban areas, which are the least monitored, especially in the case of goods trains. The study acknowledges the challenges faced by people along these tracks, ranging from minor offences to serious ones such as theft, vandalism, robbery, pilferage and sabotage (Figure 3), which are often exacerbated by inadequate infrastructure and surveillance.

A detailed classification (Figure 4) was undertaken to categorise the various types of stations within the Indian Railways network, with a specific focus on those serving passenger trains and goods trains. A wide range of criteria was analysed, including the volume of passenger traffic, the frequency and types of trains serviced, the facilities available at each station and their strategic importance in the rail network.

During the study, various types of stretches (Figure 5) that exist between railway stations were identified. Significant variations in both length and characteristics were observed in these stretches, influenced by factors such as geographical location, the terrain traversed and the infrastructure available

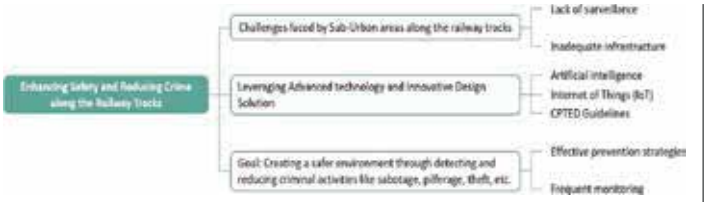

Figure 3: Enhancing safety and reducing crime along the Railway Tracks
Source: Author

Figure 4: Classification of Indian Railway's various types of Stations for Passengers and Goods Train
Source: CRIS (Centre for Railway Information Systems), Government of India, New Delhi

Figure 5: Possible types of Stretches between the Stations for Passengers and Goods Train
Source: CRIS - Centre for Railway Information Systems, Government of India, New Delhi

in those areas. For instance, stretches in mountainous regions were found to be shorter and more complex due to challenging terrain, while those in flat urban areas were longer and more straightforward. Understanding these variations was deemed crucial for optimising railway operations and ensuring efficient connectivity across the network.

The regions through which a goods train travels were examined, along with the crime monitoring scale for different areas (Figure 6). Various regions that goods trains cross were identified, considering factors such as geographical diversity, urban and rural settings and the specific challenges posed by each area. Additionally, the crime monitoring scale for these regions was assessed to understand the security landscape and potential risks associated with transporting goods. By evaluating both the geographical routes and the crime monitoring metrics, a comprehensive understanding of the

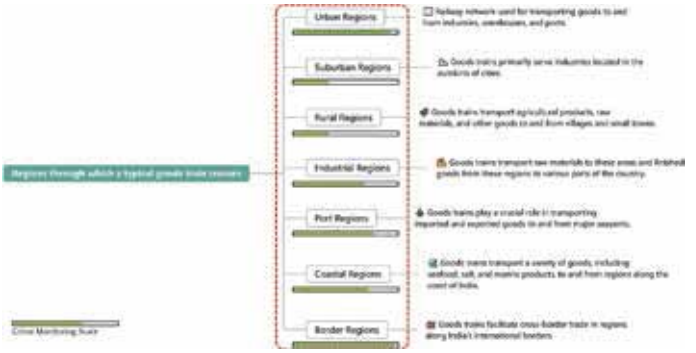

Figure 6: Regions through which a Goods Train crosses
Source: CRIS - Centre for Railway Information Systems, Government of India, New Delhi

safety and efficiency of goods train operations across different regions was achieved. This information is crucial for enhancing security measures and ensuring the smooth transit of goods throughout the railway network.

During the investigation, various types of crimes reported in Indian Railways, specifically concerning goods trains, were identified (Figure 7). A detailed examination of crime records and reports was conducted to categorise the different types of criminal activities affecting goods train operations. These crimes ranged from theft and vandalism to more organised activities such as smuggling and illegal trafficking. By understanding the nature and frequency of these crimes, a comprehensive overview of the security challenges faced by goods trains was developed. This information is crucial for the implementation of effective security measures, the enhancement of surveillance and the assurance of safe and efficient transport of goods across the railway network.

1.1 Aim

To improve safety by detecting and reducing crime along railway tracks in suburban areas through advanced technology such as AI and IoT and design solutions such as CPTED guidelines, especially in the context of goods trains.

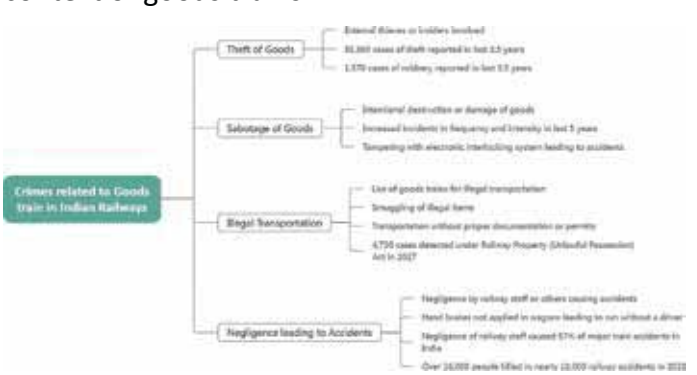

Figure 7: Types of Crimes reported at Indian Railways for Goods Trains
Source: Crime in Railways (Chapter 19); Crime in India (2015), Indian Railways

1.2 Objectives

- To understand and identify the crime rate and types of crime (where, what, with whom, why and when).
- To assess the ways in which crime can be detected, controlled and mitigated (human intervention, technology intervention viz. AI and IoT).
- To analyse the applicability of advanced technologies and CPTED guidelines for preventing crime along railway tracks, especially in the context of goods trains and in suburban or rural areas.
- To leverage the link between passenger trains and goods trains, along with their crossing regions, and map crime incidents.
- To analyse the RPF guidelines and SOPs for marshalling yards, goods sheds & freight terminals and identify the gaps.

1.3 Scope and Limitations

The scope of this study encompasses the integration of advanced technologies and design solutions to enhance the safety of goods trains in suburban areas. It focuses on geographical, technological and policy aspects, employing a mixed-method approach for comprehensive analysis. However, the study is limited by data availability, technological constraints and regulatory barriers, which may impact the generalisability and implementation of the proposed solutions.

Scope:

Geographical Focus: The study is concentrated on suburban areas where goods trains frequently operate. This includes marshalling yards, goods sheds and freight terminals in these regions.

Technological Integration: The research explores the application of advanced technologies such as Artificial Neural Networks (ANN), Internet of Things (IoT) and AI for crime detection, reporting and prevention.

Design Solutions: It evaluates the implementation of Crime Prevention Through Environmental Design (CPTED) principles tailored to suburban railway environments.

Data Analysis: The study involves a comprehensive analysis of crime data related to goods trains, identifying patterns and trends to inform safety measures.

Policy Review: The study examines existing Railway Protection Force (RPF) guidelines and Standard

Operating Procedures (SOPs) for marshalling yards, goods sheds and freight terminals to identify gaps and propose improvements.

Mixed-Method Approach: The research utilises both qualitative and quantitative methods to gather and analyse data, ensuring a holistic understanding of the issues and potential solutions.

1.4 Limitations:

Data Availability: Limited availability of specific crime data related to goods trains in suburban areas may affect the comprehensiveness of the analysis.

Technological Constraints: The implementation and testing of advanced technologies such as ANN and IoT may be constrained by current technological capabilities and infrastructure limitations.

Generalisability: Findings from suburban areas may not be directly applicable to urban or rural settings due to differing environmental and operational conditions.

Resource Limitations: The study may face constraints in terms of funding, time and access to necessary resources for extensive field research and technology deployment.

Regulatory and Policy Barriers: Existing regulations and policies may limit the scope of proposed changes and the adoption of new technologies and design solutions.

Human Factors: The effectiveness of proposed solutions may be influenced by human factors such as resistance to change, lack of training and varying levels of stakeholder engagement.

2. LITERATURE REVIEW

The critical issue of goods train safety in suburban areas has been addressed through various studies focusing on crime prevention, technological interventions and design solutions. Findings from multiple sources are synthesised in this literature review to provide a comprehensive understanding of the current state of research and to identify gaps that this study aims to address.

2.1 Crime Prevention Through Environmental Design (CPTED)

CPTED principles have been widely applied to enhance safety in various environments, including railway stations and tracks. Kubalova and Loveček (2023) highlight the effectiveness of CPTED in reducing crime by modifying the physical and social environment. Their study emphasises the importance of environmental design in preventing crimes at railway stations, which are often considered soft targets due to their accessibility and high concentration of people. Similarly, Cozens et al. (2023) developed a CPTED audit tool to assist in managing crime and anti-social behaviour in public spaces, including railway environments (Figure 8).

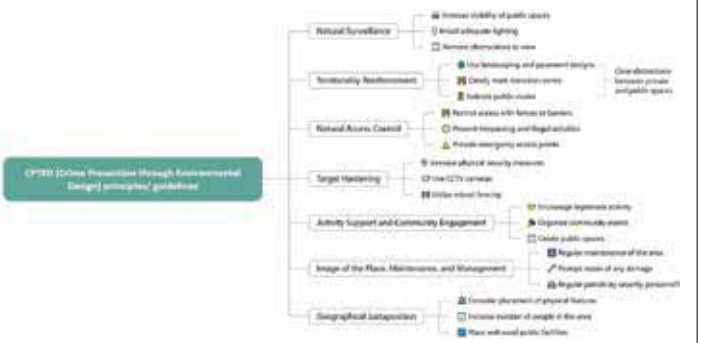

Figure 8: CPTED (Crime Prevention through Environmental Design) principles/ guidelines
Source: Cozens et al.,2023

A recent review of the UK's Secured Station Scheme (SSS) reveals that reductions in crime such as theft from the person, criminal damage and vehicle crimes were associated with stations awarded accreditation (Batley et al., 2014). This scheme, launched in 1998, has accredited more than 1,250 stations based on criteria such as achieving specific crime reduction targets and maintaining high levels of personal safety and patronage (Batley et al., 2014).

2.2 Technological Interventions

Advanced technologies such as Artificial Neural Networks (ANN), Internet of Things (IoT) and AI have shown promise in enhancing railway safety. Lorenc and Kuźnar (2018) presented a model using ANN to predict the probability of cargo theft in rail transport, demonstrating the potential of AI in crime prevention. The integration of CCTV systems for surveillance has also been explored by Kurrey and Khan (2017), who examined their role in preventing crimes against passengers and ensuring their safety.

2.3 Crime Patterns and Prevention Measures

Understanding crime patterns is crucial for developing effective prevention measures. Grabušić and Barić (2023) conducted a systematic review of railway trespassing, identifying factors that contribute to trespassing accidents and proposing measures for prevention. Their findings underscore the need for targeted interventions based on the specific characteristics of crime occurrences. Zahnow (2023) examined the protective effect of regular passengers at train stations, finding that regularity can buffer against theft and property damage, although its impact on other types of crime is limited.

2.4 Educational Measures for Trespassing Prevention

Education is considered a powerful preventive measure for reducing railway trespassing. Various stakeholders, including institutions, railway operators, communities and safety organisations, develop education-based measures. For instance, in the United Kingdom, education initiatives targeted young groups aged 16 to 25 to effectively communicate the dangers of trespassing (Grabušić & Barić, 2023). The Federal Railroad Administration also developed a community guide to identify trespassing problems through detailed analysis and surveys, which can be used to design preventive measures for specific groups.

2.5 Signalisation and Technological Measures

Preventive measures such as signalisation and technological interventions focus on restricting access and warning of dangers. Fencing along railway tracks significantly reduces trespassing but is financially costly and requires maintenance. Landscaping has shown similar results but cannot be implemented in every situation. Prohibited signs have been less effective, with their impact decreasing over time. Technical measures on trains, such as detecting unauthorised persons or objects on the tracks, raise questions about how drivers should react, especially in emergencies (Grabušić & Barić, 2023).

2.6 Policy and Guidelines

The role of policy and guidelines in enhancing railway safety cannot be overstated. Mehrotra (2017) analysed the safety standards and practices adopted by Indian Railways, highlighting the need for continuous improvement in safety measures. The study by Kanda (2015) on increasing crimes in Indian Railways further emphasises the importance of robust policies and guidelines to address safety concerns effectively.

2.7 Integration of Technologies and Design Solutions

The integration of advanced technologies with CPTED principles offers a holistic approach to crime prevention. Cozens et al. (2004) explored the implementation of CPTED at railway stations in the UK, finding that visibility and environmental design significantly influence passengers' fear of crime. Sundling and Ceccato (2022) systematically reviewed international evidence on safety perceptions in rail-bound environments, identifying key characteristics that impact passengers' sense of safety.

2.8 Safety Measures for Indian Railways

The High-Level Safety Review Committee, commonly known as the Kakodkar Committee, has provided extensive recommendations for improving safety on Indian Railways. The committee's report highlights the need for advanced signalling systems, elimination of level crossings and the adoption of modern coach designs (Mehrotra, 2017). The report also emphasises the importance of mechanisation in track maintenance to reduce human presence in high-risk areas, thereby enhancing safety (Mehrotra, 2017).

2.9 Regularity and Crime Prevention

The study by Zahnow (2023) examines the social impacts of daily mobility and its potential for crime prevention. By analysing one year of smart card travel data and police-recorded crime data, the study investigates the association between the weekly percentage of regular passengers and recorded theft, property damage, assault and motor vehicle crime at train stations. The findings suggest that regularity at stations can increase awareness of opportunities for crime, which, when coupled with crime readiness, the presence of a suitable target and the absence of capable guardianship, may trigger a crime event. The study also highlights the potential of mixed transit hubs that maximise regularity and consistent "eyes on the street" (Jacobs, 1961) to enhance safety (Zahnow, 2023).

2.10 Modelling Cargo Theft Probability Using ANN

The use of Artificial Neural Networks (ANN) to predict the probability of cargo theft in rail transport has also been explored in research. A model developed by Lorenc and Kuźnar (2018) uses factors such as the type of cargo, type of wagons, distance, delays and train speed to predict theft possibilities. Planning for drone monitoring and security control of rail line infrastructure can be supported by this method. The model's accuracy was validated using real data, showing a strong representation of theft occurrences. Decisions about additional cargo insurance for high-risk cases can also be supported by the ANN model, thereby minimising losses and costs associated with theft (Lorenc & Kuźnar, 2018).

2.11 Perceptions of CPTED at Railway Stations

Kanda (2015) provides valuable insights into the application of CPTED principles at transport terminals. The study discusses how transport terminals, due to their low level of security and high concentration of people, are considered soft targets and thus become vulnerable to terrorist attacks. The CPTED concept, which focuses on crime prevention

through environmental design, is highlighted as an effective method for enhancing security at these terminals. The study emphasises the importance of natural surveillance, access control, territorial reinforcement and maintenance as key principles of CPTED that can significantly reduce crime and improve safety at transport terminals.

2.12 Security Challenges and Measures

The security scenario on Indian Railways has been a significant concern, with incidents of sabotage increasing in frequency and intensity over the years. The terrorist attack at Mumbai Chhatrapati Shivaji Terminal in November 2008 and the derailment of the Jnaneswari Express, which was hit by an oncoming goods train in May 2010 and resulted in the death of 150 passengers, highlight the problems of railway security (Lok Sabha Secretariat, 2013). The expenditure per passenger on security was approximately Rs. 2.86 in 2009–10, indicating the need for increased investment in security measures (Lok Sabha Secretariat, 2013).

Traditionally, the Railway Protection Force (RPF) has been responsible for the security of railway assets, while state governments are responsible for the enforcement of law and order. However, coordination between the RPF and state governments has been inadequate, leading to large gaps in the railway security system (Security Management in Indian Railway, 2012). The Integrated Security System (ISS), formulated in July 2008, has yet to be fully implemented in any zone. Progress on the installation of state-of-the-art electronic surveillance systems such as Door Frame Metal Detectors (DFMDs) and baggage scanners has been slow and not up to international standards (Security Management in Indian Railway, 2012).

2.13 Trends in Railway Crimes

The trend of crimes on railways has shown a significant increase over the years. The incidence of IPC crimes reported in the country during 2013 rose by 13.4% compared with the previous year (Crime in India, 2013). Theft of passengers' belongings in Indian railways increased from 10,672 cases in 2000 to about 18,037 in 2013 (Kanda, 2015). Similarly, cases of drugging under IPC offences reported over Indian Railways increased from 200 in 2000 to 800 in 2011 (Kanda, 2015).

2.14 Dacoity, Robbery and Burglary in Railways

Dacoity, robbery and burglary are significant concerns in railway security. In 2013, a total of 61 cases of dacoity on railways were reported, with 45 cases occurring in running trains and 16 in other railway premises. These incidents accounted for 1.3% of the total 4,539 dacoity cases reported in the country that year. The value of properties stolen in these railway dacoities amounted to Rs. 56.6 lakh, with Rs. 39.0 lakh stolen from running trains and Rs. 17.6 lakh from other premises (Crime in India, 2013). In comparison, 105 cases of dacoity were reported in 2010, accounting for 2.4% of the total dacoity cases in the country, with properties worth Rs. 42.3 lakh stolen (Crime in India, 2010).

Robbery cases on railways also present a significant issue. In 2013, 741 cases of robbery were reported, with 484 occurring in running trains and 257 in other railway premises. These incidents accounted for 2.3% of the total 31,927 robbery cases reported in the country. The value of properties stolen in these railway robberies amounted to Rs. 401.7 lakh, with Rs. 313.1 lakh stolen from running trains and Rs. 88.6 lakh from other premises (Crime in India, 2013). In 2010, 517 cases of robbery were reported, accounting for 2.2% of the total robbery cases in the country, with properties worth Rs. 153.2 lakh stolen (Crime in India, 2010).

Burglary on railways, though less frequent, still poses a threat. In 2013, 74 cases of burglary were reported, with 2 occurring in running trains and 72 in other railway premises. These incidents accounted for 0.7% of the total 1,04,401 burglary cases reported in the country. The value of properties stolen in these railway burglaries amounted to Rs. 31.8 lakh (Crime in India, 2013). In 2010, 67 cases of burglary were reported in Jammu & Kashmir, followed by 13 in Bihar (Crime in India, 2010).

2.15 Theft in Railways

Theft is the most common crime on railways. In 2013, a total of 18,052 cases of theft were reported, with 12,107 occurring in running trains and 5,945 in other railway premises. These incidents accounted for 4.8% of the total 3,72,622 theft cases reported in the country. The value of properties stolen in these railway thefts amounted to Rs. 7,008.1 lakh, with Rs. 5,051.8 lakh stolen from running trains and Rs. 1,956.3 lakh from other premises (Crime in India, 2013). In 2010, 15,176 cases of theft were reported, accounting for 4.6% of the total theft cases in the country, with properties worth Rs. 3,971.7 lakh stolen (Crime in India, 2010).

Security has been identified as one of the priority areas for upgradation and strengthening on Indian Railways. The Railway Protection Force (RPF), which functions under the Ministry of Railways, has been

entrusted with the responsibility of protecting passengers, passenger areas and railway property. The Integrated Security System (ISS) was proposed for 202 important railway stations to enhance security through multiple layers of checking and surveillance. This system includes components such as CCTV surveillance, access control, personal and baggage screening and bomb detection and disposal systems (Security Management in Indian Railway, 2012).

2.16 Railway Safety Review Committees

Several committees have been constituted to review and recommend measures for improving railway safety. The Khanna Committee (1998), Sikri Committee (1978), Wanchoo Committee (1968) and Kunzru Committee (1962) have all contributed to the development of safety protocols. The Khanna Committee, in particular, recommended a one-time grant of Rs. 15,000 crores to address arrears in the renewal of vital safety equipment (Lok Sabha Secretariat, 2013).

2.17 Corporate Safety Plan (2003–2013)

In response to the recommendations of the Railway Safety Review Committee, the Corporate Safety Plan (2003–2013) was formulated. This plan aimed to enhance safety across various aspects of railway operations, including passenger safety, road user safety, accident reduction, asset reliability and prompt rescue and relief operations. The plan involved a total outlay of Rs. 31,385 crores, sourced from various funds, to achieve these safety objectives (Lok Sabha Secretariat, 2013).

2.18 High Level Safety Review Committee

The High-Level Safety Review Committee, chaired by Dr Anil Kakodkar, was constituted in 2011 to address technical and technology-related aspects of railway safety. The committee made 106 recommendations covering various safety-related issues, including organisational structure, manpower planning, signalling, rolling stock, track maintenance and human resource development. It proposed an investment of Rs. 1,00,000 crores over five years to implement these recommendations (Lok Sabha Secretariat, 2013).

Summary Findings and Research Gaps

CPTED principles and guidelines have been applied in urban areas, especially for railway stations and their surroundings, but no research is available on improving safety or the applicability of CPTED along railway tracks in suburban areas in the case of goods trains. (In India, CPTED principles were incorporated in 2019 for Smart City projects, but not for improving safety along railway tracks in suburban areas.)

Data are available for passenger trains (in terms of CPTED guidelines or RPF guidelines), but none for freight/goods trains. For goods trains, Standard Operating Procedures (SOPs) exist for marshalling yards, goods sheds & freight terminals but not for stretches beyond these yards that pass through rural or suburban regions.

In RPF crime prevention guidelines, crimes related to goods trains have not been captured, and CPTED parameters have not yet been included. Despite efforts to improve railway security, issues regarding inter-agency coordination between the RPF, GRP and state police persist. The increase in accidents due to sabotage and successful *rail roko* agitations indicates the need for better cooperation between Indian Railways and state governments. The Integrated Security System (ISS), formulated in 2008, has not been fully implemented, and there are gaps in the security system at railway stations. Unauthorised entry points, inadequate lighting and slow installation of electronic surveillance systems contribute to these vulnerabilities (Security Management in Indian Railway, 2012).

Conclusion

The reviewed literature highlights the importance of combining technological interventions with design solutions to enhance the safety of goods trains in suburban areas. While significant progress has been made, there are still gaps in data availability, technological constraints and policy implementation that need to be addressed. This study seeks to fill these gaps by proposing an integrated approach that leverages advanced technologies and CPTED principles to improve railway safety.

3. METHODOLOGY

The methodology (Figure 9) employed in the study on improving safety along railway tracks in suburban areas for goods trains through advanced technology and design solutions is outlined in this section. The appropriateness and validity of the outcomes are ensured by the methodology, which provides sufficient detail for replication by other researchers.

3.1 Setting of the Study

The study focuses on suburban areas where goods trains frequently operate. These areas include marshalling yards, goods sheds and freight terminals. The geographical scope is limited to regions with significant goods train traffic and reported safety

Figure 9: Methodology
Source: Author

issues, particularly in India given its extensive railway network.

3.2 Sampling Strategy and Case Study Selection Criteria

The sampling strategy involves a purposive sampling method to select case study locations. The criteria for selection include:

- High Incident Locations: Areas with a high frequency of crimes related to goods trains, identified through Railway Protection Force (RPF) incident statistics and discussions with railway management.
- Diverse Environments: Locations representing a mix of residential, agricultural and industrial land use along railway tracks.
- Stakeholder Involvement: Areas with active involvement of local government agencies, community organisations and railway authorities.

3.3 Research Design

The research design is a mixed-method approach, combining qualitative and quantitative methods to provide a comprehensive understanding of the issues. The study is structured in four stages:

- Problem Scoping: Identifying and understanding the nature and causes of safety issues along railway tracks.
- Intervention Planning: Developing and planning interventions based on the identified issues.
- Implementation: Executing the planned interventions in selected case study locations.
- Evaluation: Assessing the effectiveness of the interventions and the overall impact on railway safety.

3.4 Methods and Tools for Data Collection

Qualitative Methods

- Semi-structured Interviews: In-depth interviews with senior RPF security managers and local government officials to gain insights into their perspectives on safety issues and interventions.
- Focus Groups: Organising focus groups with community members, youth workers and other relevant stakeholders to gather diverse viewpoints and identify local concerns.
- Observational Studies: Field observations at selected railway locations to document safety conditions and behaviours**.**

Quantitative Methods

- Surveys: Structured questionnaires distributed to railway staff, passengers and local residents to collect data on crime rates, types of crimes and perceptions of safety.
- Crime Data Analysis: Analysis of RPF crime records to identify patterns and trends in railway-related crimes.

3.5 Documentation of Data

All data collected through interviews, focus groups, surveys and observations are systematically documented. Audio recordings of interviews and focus groups are transcribed verbatim. Survey responses are digitised and stored in a secure database. Observational notes are recorded in field journals.

3.6 Data Analysis Framework

Qualitative Analysis

- Thematic Analysis: Coding and categorising qualitative data to identify recurring themes and patterns related to safety issues and interventions.
- Soft Systems Methodology (SSM): Used to develop a holistic understanding of the problem situation, including the perspectives of different stakeholders. The CATWOE (Customers, Actors, Transformation processes, Worldviews, Owners, Environmental constraints) approach ensures that all influences within complex problems are acknowledged.

Quantitative Analysis

- Descriptive Statistics: Summarising survey data to provide an overview of crime rates, types of crimes and safety perceptions.
- Inferential Statistics: Statistical tests conducted

to determine the significance of relationships between variables, such as the impact of interventions on crime rates.

Ethical Considerations
The study adheres to ethical guidelines to ensure the confidentiality and anonymity of participants. Informed consent is obtained from all interviewees and survey respondents. The research is conducted with respect for the rights and dignity of all participants.

Replicability
The detailed documentation of the methodology, including the setting, sampling strategy, research design, data collection methods and analysis framework, ensures that the study can be replicated by other researchers. The use of established methods such as SSM and thematic analysis further enhances the reliability and validity of the findings.

Conclusion
This methodology provides a robust framework for investigating and improving the safety of goods trains in suburban areas. By integrating advanced technologies and design solutions, the study aims to address existing gaps and contribute to the development of more effective safety measures in railway transportation systems.

4. DATA ANALYSIS AND FINDINGS

In this section, the collected data and the analysis performed to understand and improve the safety of goods trains in suburban areas are summarised. Data were gathered through a combination of qualitative and quantitative methods, including interviews, focus groups, surveys and crime data analysis. The findings are presented to justify the conclusions drawn from the study.

4.1 Qualitative Data Analysis

Semi-structured Interviews
In-depth interviews were conducted with senior RPF security managers and local government officials. Several key themes emerged from the thematic analysis of these interviews:

- Inadequate Surveillance: Many officials highlighted the lack of adequate surveillance systems along railway tracks, particularly in suburban areas. This gap significantly contributes to the high incidence of crimes such as theft and vandalism.
- Resource Constraints: Both RPF managers and local officials pointed out the limited resources available for implementing advanced security measures. The deployment of technologies such as AI and IoT is often hindered by budget constraints.
- Community Involvement: There was a consensus on the need for greater community involvement in crime prevention. Officials suggested that local communities could play a crucial role in monitoring and reporting suspicious activities.

Focus Groups
Additional insights were provided by focus groups with community members, youth workers and other stakeholders:

- Perception of Safety: Many community members expressed concerns about safety when near railway tracks. Frequent incidents of theft and vandalism, which create a sense of insecurity, were reported.
- Effectiveness of CPTED: Participants generally agreed that Crime Prevention Through Environmental Design (CPTED) principles could enhance safety. However, they emphasised the need for proper implementation and maintenance of these design solutions.
- Technology Acceptance: A mixed response to the use of advanced technologies was observed. While some participants were optimistic about the potential of AI and IoT in crime prevention, others raised scepticism about their effectiveness and concerns about privacy.

4.2 Quantitative Data Analysis

Surveys
Structured questionnaires were distributed to railway staff, passengers and local residents. Descriptive and inferential statistics were used to analyse the survey data:

- **Crime Rates and Types:** The survey results indicated that theft (45%), vandalism (30%) and pilferage (15%) were the most common crimes reported along railway tracks. The remaining 10% included incidents of robbery and sabotage.
- **Perceptions of Safety:** Approximately 60% of respondents reported feeling unsafe near railway tracks, particularly at night. This perception was more pronounced among residents living close to marshalling yards and freight terminals.
- **Effectiveness of Interventions:** The effectiveness of CPTED principles and advanced technologies was rated higher (70%) by respondents who

were aware of these interventions compared with those who were not familiar with them (40%).

Crime Data Analysis

Crime data from RPF records were analysed to identify patterns and trends:

- **Temporal Patterns:** The analysis revealed that most crimes occurred during late evenings and early mornings. This pattern suggests the need for enhanced surveillance during these hours.
- **Spatial Patterns:** High-crime areas were typically located near marshalling yards and goods sheds. These locations often lacked adequate lighting and surveillance, making them vulnerable to criminal activities.
- **Impact of Interventions:** Preliminary data from areas where CPTED principles and advanced technologies were implemented showed a reduction in crime rates of approximately 20%. However, some areas did not show significant improvement, indicating the need for further refinement of these interventions.

Contradictory Findings

While the overall findings support the effectiveness of CPTED principles and advanced technologies, some contradictory results were observed:

- **Community Resistance:** In certain areas, the implementation of surveillance technologies was resisted by community members due to privacy concerns. This resistance hindered the effectiveness of the interventions.
- **Resource Allocation:** Despite the positive impact of advanced technologies, their widespread deployment was limited by resource constraints. Some officials argued that traditional methods such as increased patrolling might be more cost-effective in specific contexts.

Conclusion

The data analysis highlights the importance of integrating advanced technologies and CPTED principles to enhance the safety of goods trains in suburban areas. While the findings generally support the effectiveness of these interventions, the study also underscores the need to address resource constraints and community concerns. By refining and adapting these solutions, a safer and more secure railway environment can be created.

5. RESULT AND DISCUSSION

5.1 Results

5.1.1 Qualitative Findings

Semi-structured Interviews

Several critical insights were revealed through the interviews with senior RPF security managers and local government officials:

- Inadequate Surveillance: A significant number of officials highlighted the lack of adequate surveillance systems along railway tracks, particularly in suburban areas. This gap contributes significantly to the high incidence of crimes such as theft and vandalism.
- Resource Constraints: Limited resources were frequently mentioned as a barrier to implementing advanced security measures. The deployment of technologies such as AI and IoT is often hindered by budget constraints.
- Community Involvement: There was consensus on the need for greater community involvement in crime prevention. Officials suggested that local communities could play a crucial role in monitoring and reporting suspicious activities.

Focus Groups

Additional insights were provided by focus groups with community members, youth workers and other stakeholders:

- Perception of Safety: Many community members expressed concerns about their safety near railway tracks. Frequent incidents of theft and vandalism, which create a sense of insecurity, were reported.
- Effectiveness of CPTED: Participants generally agreed that Crime Prevention Through Environmental Design (CPTED) principles could enhance safety. However, they emphasised the need for proper implementation and maintenance of these design solutions.
- Technology Acceptance: A mixed response to the use of advanced technologies was observed. While some participants were optimistic about the potential of AI and IoT in crime prevention, others raised scepticism about their effectiveness and concerns about privacy.

5.1.2 Quantitative Findings

Surveys

The survey data provided a comprehensive overview of crime rates, types of crimes and perceptions of safety:

- Crime Rates and Types: Theft (45%), vandalism (30%) and pilferage (15%) were the most common crimes reported along railway tracks. The remaining 10% included incidents of robbery and sabotage.
- Perceptions of Safety: Approximately 60% of respondents reported feeling unsafe near railway tracks, particularly at night. This perception was more pronounced among residents living close to marshalling yards and freight terminals.
- Effectiveness of Interventions: The effectiveness of CPTED principles and advanced technologies was rated higher (70%) by respondents who were aware of these interventions compared with those who were not familiar with them (40%).

Crime Data Analysis

Several patterns and trends were identified through the analysis of crime data from RPF records:

- Temporal Patterns: The analysis revealed that most crimes occurred during late evenings and early mornings. This pattern suggests the need for enhanced surveillance during these hours.
- Spatial Patterns: High-crime areas were typically located near marshalling yards and goods sheds. These locations often lacked adequate lighting and surveillance, making them vulnerable to criminal activities.
- Impact of Interventions: Preliminary data from areas where CPTED principles and advanced technologies were implemented showed a reduction in crime rates of approximately 20%. However, some areas did not show significant improvement, indicating the need for further refinement of these interventions.

5.2 Discussion

5.2.1 Aim and Hypotheses

The aim of this study was to improve safety along railway tracks in suburban areas for goods trains through advanced technology and design solutions. The hypotheses were that the integration of advanced technologies (such as AI and IoT) and CPTED principles would significantly reduce crime rates and enhance the perception of safety among community members.

5.2.2 Interpretation of Results

Inadequate Surveillance and Resource Constraints

The findings from the interviews and focus groups underscore the critical need for improved surveillance systems. The lack of adequate surveillance is a major factor contributing to the high incidence of crimes. Resource constraints, particularly budget limitations, were frequently mentioned as barriers to implementing advanced security measures. This highlights the need for strategic allocation of resources and potential funding from government and private sectors to enhance railway safety.

Community Involvement and Perception of Safety

The importance of community involvement in crime prevention was a recurring theme. Engaging local communities in monitoring and reporting suspicious activities can create a more secure environment. The perception of safety among community members is crucial, as it directly impacts their willingness to participate in safety initiatives. The mixed response to advanced technologies suggests that while there is optimism about their potential, concerns about privacy and effectiveness need to be addressed through transparent communication and demonstration of benefits.

Effectiveness of CPTED and Advanced Technologies

The hypothesis that CPTED principles and advanced technologies can enhance safety is supported by the survey and crime data analysis. Areas where these interventions were implemented showed a reduction in crime rates and higher ratings of effectiveness. However, participants emphasised the need for proper implementation and maintenance of CPTED solutions. The preliminary reduction in crime rates by 20% in some areas indicates the potential of these interventions, while also highlighting the need for continuous evaluation and refinement.

5.2.3 Theoretical Implications and Practical Implications

Theoretical Implications: This study contributes to the theoretical understanding of crime prevention in railway environments through the integration of CPTED principles with advanced technologies. It provides evidence that a holistic approach combining environmental design and technological interventions can effectively reduce crime and enhance safety.

Practical Implications: The findings suggest that the implementation of surveillance systems should

be prioritised by railway authorities and resources allocated strategically to areas with high crime rates. Engaging local communities in safety initiatives and addressing their concerns about privacy and the effectiveness of technologies can enhance the overall impact of interventions. The study also underscores the importance of continuous evaluation and refinement of safety measures to ensure their effectiveness.

5.2.4 Importance of Findings

The findings of this study are significant as they address the critical issue of railway safety in suburban areas, which has been relatively overlooked. By demonstrating the effectiveness of integrating advanced technologies and CPTED principles, the study provides a roadmap for enhancing safety and reducing crime along railway tracks. The insights gained from this research can inform policy decisions and guide the implementation of safety measures in other regions facing similar challenges.

In conclusion, the study highlights the potential of advanced technologies and design solutions in transforming railway security. By addressing resource constraints, engaging communities and continuously refining interventions, it is possible to create a safer and more secure railway environment. This research contributes to the broader goal of improving the efficiency and reliability of railway transportation systems, ultimately benefiting society as a whole.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The primary aim of this study was to improve safety along railway tracks in suburban areas for goods trains through the integration of advanced technology and design solutions. The hypothesis that combining Crime Prevention Through Environmental Design (CPTED) principles with advanced technologies such as Artificial Intelligence (AI) and the Internet of Things (IoT) can significantly enhance safety and reduce crime rates is supported by findings from both qualitative and quantitative data.

The study revealed that inadequate surveillance and resource constraints are major barriers to effective crime prevention along railway tracks. Community involvement was identified as a crucial factor in enhancing safety, with local residents playing a key role in monitoring and reporting suspicious activities. The implementation of CPTED principles and advanced technologies produced promising results, with a notable reduction in crime rates in areas where these interventions were applied.

6.2 Practical Significance

The practical significance of these outcomes is substantial. By addressing the identified gaps in surveillance and resource allocation, railway authorities can create a safer environment for goods trains in suburban areas. More effective crime prevention strategies can be achieved through the integration of advanced technologies and CPTED principles, ultimately improving the efficiency and reliability of railway transportation systems.

The results of this study explain real-life phenomena such as the reduction in theft, vandalism and other crimes along railway tracks. Enhanced surveillance and community involvement can deter criminal activities, while the application of CPTED principles can create environments less conducive to crime. These improvements can lead to increased confidence among railway staff and local residents, fostering a sense of security and well-being.

6.3 Unresolved Problems and Further Research

Despite the positive outcomes, several problems remain unresolved. Resource constraints continue to be a significant barrier to the widespread implementation of advanced technologies. In addition, community resistance to surveillance technologies due to privacy concerns needs to be addressed through transparent communication and demonstration of benefits.

Further research is needed to explore the following areas:

- Cost-effective Solutions: Cost-effective ways to implement advanced technologies and CPTED principles in resource-constrained environments should be investigated. This could include exploring alternative funding sources and partnerships with private sector entities.
- Community Engagement Strategies: Strategies to enhance community engagement and address privacy concerns need to be developed and tested. Research could focus on building trust and demonstrating the tangible benefits of surveillance technologies to local residents.

6.4 Recommendations

Based on the findings of this study, the following actions are recommended to improve safety along railway tracks in suburban areas:

- **Enhanced Surveillance Systems:** Investment in advanced surveillance systems, including AI and IoT technologies, is needed to monitor high-

crime areas effectively. The deployment of these systems should be prioritised in marshalling yards, goods sheds and other vulnerable locations.

- **Resource Allocation:** Resources should be allocated strategically to areas with the highest crime rates. Additional funding from government and private sector sources should be sought to support the implementation of advanced technologies and CPTED principles.
- **Community Involvement:** Local communities should be engaged in crime prevention efforts. Community watch programmes should be established and training provided on how to report suspicious activities. Privacy concerns should be addressed through transparent communication and by demonstrating the benefits of surveillance technologies.
- **Continuous Evaluation:** A continuous evaluation process should be implemented to assess the effectiveness of safety interventions. The findings should be used to refine and improve crime prevention strategies over time.

By taking these steps, railway authorities can create a safer and more secure environment for goods trains in suburban areas, ultimately enhancing the overall efficiency and reliability of railway transportation systems.

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RESEARCH PAPER

Examining the Changing Preferences of Social Interaction Modes in Urban Areas

By Shweta Pradeep Patil and Dr. G. Karteek

Abstract

Traditionally, social interactions used to take place in physical locations, usually in informal settings and located within neighborhoods. These places, known as the third places, were often visited by the locals and promoted overall health by allowing people to engage in creative activities. But in recent years, there has been a noticeable shift in where we gather and interact socially. The advancement in technology and the recent pandemic have popularized the use of digital platforms for socializing. Therefore, this research aims to study the aspects of online and in-person social interactions to understand which is preferred and why. The study was conducted through an online survey, incorporating questions regarding demographics, characteristics, frequency, and quality of online and offline interactions, as well as the role of the built environment in supporting social interactions. The results show that the choice of mode of interaction changes according to age and the qualities associated with it. The notion that young people prefer online interactions and older people rely more on in-person interactions is not entirely true. Additionally, technological advancements cannot replace the essence of physical socializing places and their need in today's world, where digital socializing platforms may create isolation among people.

Keywords: online interaction, social interaction, spatial experience, third places, urban areas.

1. Introduction

One of the most prominent concepts associated with social spaces is that of third places. The concept of third places was coined by the American urban sociologist Ray Oldenburg. These are informal public gathering places outside the home (first place) and work (second place), which bring balance in daily life and make it relaxing and fulfilling (Oldenburg, 1997). Among its eight criteria mentioned by Oldenburg, the most indicative one is "that the talk there is good" (Oldenburg, 1999). Thus, implying that social interaction is an essential activity in these places. Apart from public facilities like libraries and parks, certain commercial establishments such as coffee shops, cafes, bars, beauty salons, barbershops, bowling alleys, gyms, childcare facilities, recreation and community centers, places of worship, and shopping malls also form third places (Finlay et al., 2019). They are places where people are most lively and are their true selves (Oldenburg, 1999).

In the Indian context, *addas*, *chowks,* ghats, *nakas*, religious places, tea stalls, etc., have traditionally served as informal social spaces. These places build perceptions of security, confidence and comfort by fostering a sense of community and belonging (Finlay et al., 2019). They influence community sentiment not only by offering resources and social connections but also as a representation of location and social interaction within that location (Williams & Hipp, 2019). Seemingly ordinary in nature, they are connected with quality of life, wellbeing and health, making them essential to everyday life (Finlay et al., 2019).

Lately, the traditional physical-social-cultural places of social interaction have witnessed major changes due to the rapid integration of technology (Kennedy & Lynch, 2016). The invention of the internet and the wide reach of information and communication technology have enabled newer opportunities for

socializing through digital platforms. Additionally, due to the increasing number of individuals opting to reside in smaller households or live independently (Ali & George, 2022), the dependence on online platforms to stay connected is increasing. From text and voice messages to audio and video calling facilities, these online modes for social interaction are advancing day by day.

Many researchers have extensively studied the features and impacts of online platforms and physical informal places for social interaction. Kennedy and Lynch (2016) have studied social participation among adolescents, and Yau and Reich (2017) have studied whether the qualities of face-to-face friendships are present in digital interactions. Lieberman and Schroeder (2019) studied the influence of differences between online and offline interactions on social outcomes of teenagers and adults (18-24 years). Nguyen et al. (2022) deliberate the possibility of maintaining social connectedness through digital communication among adults when they are physically apart. English and Carstensen (2014) and Wrzus et al. (2013) have studied the changing social networks across adulthood and lifespan.

However, most of these studies pertain to one particular age group or a comparison of two age groups. Studies considering all the age groups and in an Indian context are limited. Therefore, this research aims to understand the changing preferences of modes of interaction among different age groups and their effects. By studying the qualities of the two modes of interaction, i.e., online and offline, and the reasons why they are preferred, we can identify the current needs, their advantages and drawbacks and provide directions for future research.

2 Literature review

2.1 Social interaction in physical places

In-person interactions have been the primary method of communication for thousands of years (Lieberman & Schroeder, 2019). These in-person interactions allow communication of emotions through nonverbal cues such as exchange of smiles, touch and voice modulations (Lieberman & Schroeder, 2019). Along with verbal elements, non-verbal cues emphasize conversations and make them satisfying (Misra, S. et al., 2016). Laughter and humor in social environments can uplift personal spirits and foster stronger friendships (Nadizti et al., 2021).

Spatially, social interactions occur in third places, which accommodate informal activities where different types of people, irrespective of their social status, are allowed to create experiences in public life (Widyaningsih et al., 2021). There are various advantages of having social interactions in physical places. They help form and sustain casual social relationships by providing possibilities for daily informal face-to-face interaction (Granovetter 1983). The physical surroundings can engage individuals by providing sensory-rich spatial experiences (Nadizti et al., 2021).

Informal meeting spots encourage conversations, debates, and knowledge dissemination, acting as a form of community space for the common good (Nadizti et al., 2021). In contrast to people's more serious involvement in other places, these places tend to have a humorous mood (Oldenburg, 1999). They can bring in a feeling of a collective comfortable home for everyone (Hawkins & Ryan, 2013). The values these places provide, such as well-being, social inclusion, sense of community and social capital accumulation, can give individuals a feeling of collectiveness (Hawkins & Ryan, 2013). They are inclusive in nature and do not set formal norms for membership and exclusion (Oldenburg, 1999). Physical characteristics of the environment, such as street furniture, shade on the street, sidewalk width and articulation of building facades, also support social behaviors (Mehta & Bosson, 2018).

Over the years, several researchers, Hawkins and Ryan (2013), Jacke (2009), Slater and Koo (2010), and Melnick (1993), have examined festivals, music clubs, arts venues and sports stadiums as possible third places. For example, a study conducted by Dolley (2020) showed that community gardens can serve as potential third places as they are likely to ignite conversations and engage neighborhood people both actively and passively. Community gardens contribute to placemaking by cultivating a stronger sense of community and civic pride, while connecting individuals with nature and each other (Dolley, 2020). Similarly, research conducted by Hindley (2018) found that parkrun created an inclusive environment for casual social interaction, while also enabling a collective experience of exercising together.

2.2 Social interaction online

The integration of technology has brought a change in the settings of social participation (Kennedy & Lynch, 2016). The social order of society has been reorganized by the network logic innate in digitally mediated portable communication devices, which no longer define social interactions and activities in terms of their location and time of occurrence (Vanden Abeele, 2018). Online technology has enabled individuals to converse easily with people globally, irrespective of the distance barrier and helps

maintain and expand social networks (Lieberman & Schroeder, 2019). We can use smartphones, tablets and laptops to interact with people whenever we want (Vanden Abeele, 2018).

In situations where face-to-face interactions are not possible, various information and communication technologies help stay socially connected (Nguyen et al., 2022). Online interactions can be used to support relationships and ensure that people remain in contact even after they move away from each other due to life changes, and do not necessarily remove people from their offline world (Ellison et al., 2007). Mobile communication provides individuals flexibility to organize activities and arrange when and where they start and end (Vanden Abeele, 2018). Online interactions facilitate passive browsing, enabling individuals to view social profiles and read opinions anonymously (Lieberman & Schroeder, 2019).

The research conducted by Lenhart et al. (2015) found that text or instant messaging was more likely to be used among young people for daily interactions than in-person interactions. The vigorous use of social networking sites demonstrates its potential to enhance well-being and social support by building both bonding social capital (close relationships) and bridging social capital (acquaintances and broader connections) (Ellison et al., 2007).

Social participation on the internet has positive influences (Kennedy & Lynch, 2016), but it also has certain liabilities (Yau & Reich, 2017). A study by Kushlev et al. (2019) has shown that when people have access to their smartphones, they are less likely to smile and engage in casual interactions with people in their surroundings. The younger generations are constantly seeking social validation through online participation and this may have direct implications on the individual's sense of identity, confidence and self-worth (Kennedy & Lynch, 2016). As technology takes over even simple face-to-face exchanges, individuals may miss out on fulfilling their basic need for real-life social connections (Kushlev et al., 2017).

2.3 Age and socializing

Social networks are shaped and possibly driven by life events, occurring in a way that corresponds to age-related stages (Wrzus et al., 2013; Zhaoyang et al., 2018). These events, such as puberty, job entry, marriage and parenthood, bring about changes in social networks that closely reflect the age-related network changes typical of these life stages (Wrzus et al., 2013). Throughout adolescence, intense social and emotional development takes place, leading to a search for identity and increased influence of peers. Erikson's theory of identity vs. role confusion (1968) suggests that through social interactions with peers, adolescents are actively exploring their sense of self. Due to constant seeking of validation, support and feedback from peers, these relationships during adolescence are crucial.

In adolescence and young adulthood, the global, personal and friendship networks expand, reaching a plateau in the mid-20s to early 30s (Wrzus et al., 2013). In adulthood, various factors such as career, family life, and broader social networks influence the social interaction patterns. The importance of forming close friendships and meaningful relationships during early adulthood is emphasized by Erikson's stage of intimacy vs. isolation (1950). During this period, the focus is mainly on gathering knowledge and information from various sources (Wrzus et al., 2013). Within professional networks, peripheral social connections play an important role in accessing information and opportunities (Granovetter, 1973).

As people get older, they often shape their social networks to focus more on close relationships, such as with family and close friends, which bring them greater emotional satisfaction and minimize time spent with more distant, less satisfying acquaintances (English & Carstensen, 2014). A social support network is one of the aspects of social connectedness, which is a major factor influencing the quality of life among older adults (Lee & Tan, 2019). According to the socioemotional selectivity theory proposed by Carstensen in 1987, 1991

> '…reduced rates of interaction in late life are viewed as the result of lifelong selection processes by which people strategically and adaptively cultivate their social networks to maximize social and emotional gains and minimize social and emotional risks' (Carstensen, 1992, p. 331).

Thus, it is observed that the social networks expand until middle age, after which they decrease in size during late middle age and old age as people begin to exclude peripheral relationships (English & Carstensen, 2014).

3 Methodology

3.1 Data

The data was collected through an online survey. The parameters for the questions were guided by a literature study. A structured questionnaire was prepared, consisting of five parts:

- Name, age group, which city they live in and mode used for interaction.
- Places where participants are likely to form new connections, environments fostering creativity and exchange of ideas and places that create a sense of belonging and offer personal growth.
- Amount of time spent on online interactions and in-person interactions, and the place of visit.
- What do they like about interacting online and offline, and the types of conversations made online and offline?
- Importance of physically meeting, does the built environment play a role, importance of non-verbal cues and effectiveness of offline interactions.

An optional question was provided in the end where participants could mention their views on online and offline interactions. A total of 163 responses were recorded across four age groups and four cities.

Based on the literature, the age parameter was divided into four groups: up to 18 years (adolescents), 19-30 years (young adults), 31-50 years (mid-aged adults) and 51 years and above (older adults). Four Indian cities, namely Bengaluru (Karnataka province), Hyderabad (Telangana province), Mumbai (Maharashtra province) and Pune (Maharashtra province), were chosen for the survey. All four cities boast a vibrant cosmopolitan culture. The cities of Bengaluru, Hyderabad, and Pune possess IT influence, whereas the city of Mumbai is mostly finance and business-oriented. The cities of Bengaluru, Hyderabad, Mumbai and Pune have an extent of 741 sq. km, 650 sq. km, 157 sq. km and 340.45 sq. km, respectively.

3.2 Data analysis

The analysis was carried out using the method of Thematic Analysis. Through a deductive analysis approach, the qualitative data were analyzed and patterns were identified. Nine codes were generated based on these patterns. These codes were then organized into three themes (Figure 1). The results were obtained by comparing the codes with age groups to identify preferences, reasons of choice and their advantages and disadvantages.

4. Results

4.1 Attributes

Four main attributes of physical third places and online socializing platforms were identified. A comparison between the mode of interaction and age group revealed which mode fostered the attribute.

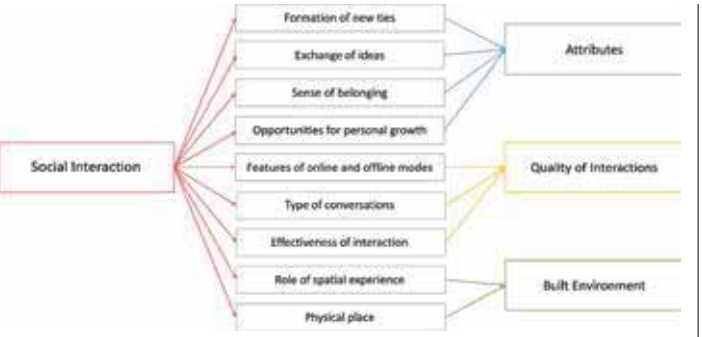

Figure 1: Thematic analysis coding
Source: Authors

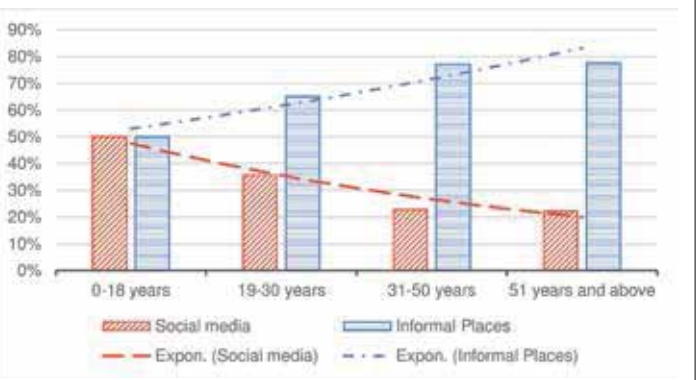

Figure 2: Likelihood of forming new connections outside the social circle
Source: Authors

All participants reported the use of both online and offline modes for socializing and interacting. Making connections and finding regulars is an initial attribute of socializing. When forming new connections, 70% participants tended to do so in physical, informal places. When compared with age groups, we found that adolescents formed new connections on online socializing platforms, but they equally did so in physical, informal places. Whereas participants above the age of 30 were less likely to make new connections through online socializing platforms (Figure 2).

The second attribute dealt with the environment of third places. These places provide an environment that stimulates creativity and fosters the exchange of ideas. A trend similar to that of the first attribute was found, wherein, as the age group increased, the participants' choice of mode of interaction gradually shifted from online platforms to physical places (Figure 3).

The third attribute was about a sense of belonging. Participants across all age groups said both online socializing platforms and physical informal places provide a sense of belonging. But when compared between the two modes, participants felt a stronger sense of belonging in physical informal places, irrespective of the age group they belonged to. It

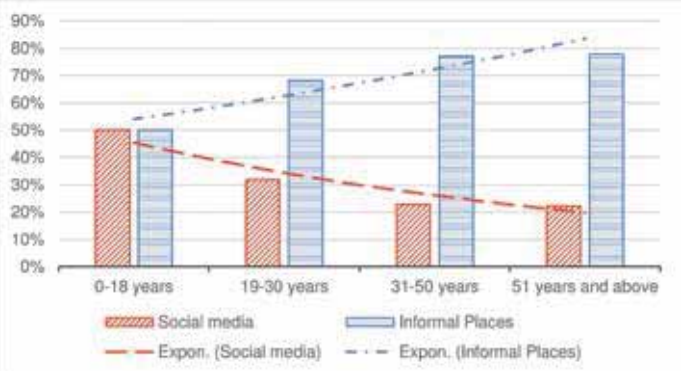

Figure 3: Environment fostering creativity and exchange of new ideas
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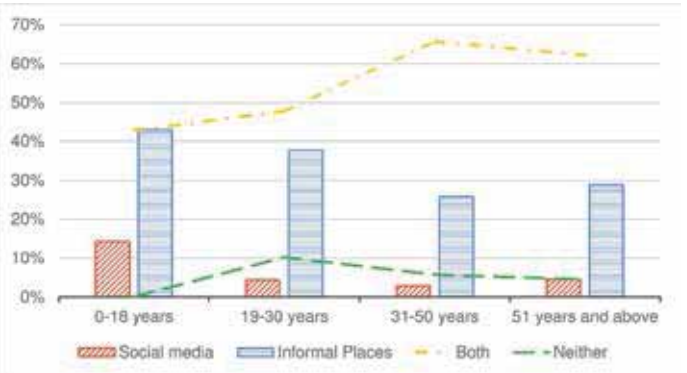

Figure 4: Place forming sense of belonging
Source: Authors

is also interesting to note that 42.9% adolescent participants felt valued and accepted in physical informal spaces (Figure 4).

The fourth important attribute of these places is that they offer opportunities for personal growth through shared experiences and exposure to different perspectives. Participants across all age groups unanimously said that both online socializing platforms and physical informal places provide such opportunities. Between the two modes, adolescents and mid-aged adults found these opportunities and exposures only in physical informal places. Whereas older adults found more opportunities and exposures on online socializing platforms (Figure 5).

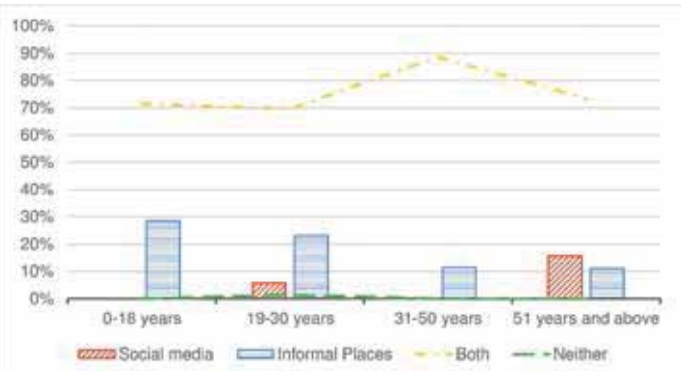

Figure 5: Place offering opportunities for personal growth
Source: Authors

4.2 Quality of interactions

Online and offline interactions have different features associated with them, due to which people prefer that mode of interaction. 57% adolescents preferred online modes for interaction as it facilitated immediate connectivity. Whereas, 53% older adults preferred online interaction due to its global connectivity. The results show that participants used online socializing platforms because they enabled conversations irrespective of the distance barrier and when it was not feasible to have in-person meetings. They were good means to get or pass information quickly. It is interesting to note that middle-aged adults preferred online interactions because it is time-saving. Also, due to not being time-bound, participants could leave messages at any time knowing that the conversation would be continued (Figure 6). One common opinion the participants had about online interactions is that they were more prone to being misunderstood when compared to offline interactions.

It was observed that in a day, young adults and older adults spent 1-2 hours on online platforms for social interaction. Whereas middle-aged adults spent less than an hour for the same (Figure 7).

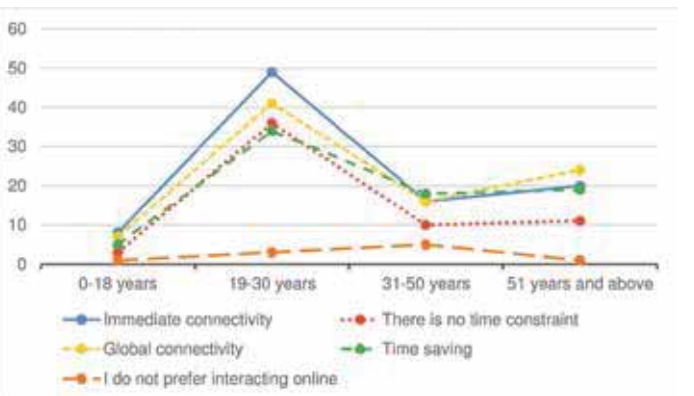

Figure 6: Reasons for preferring online mode for interaction
Source: Authors

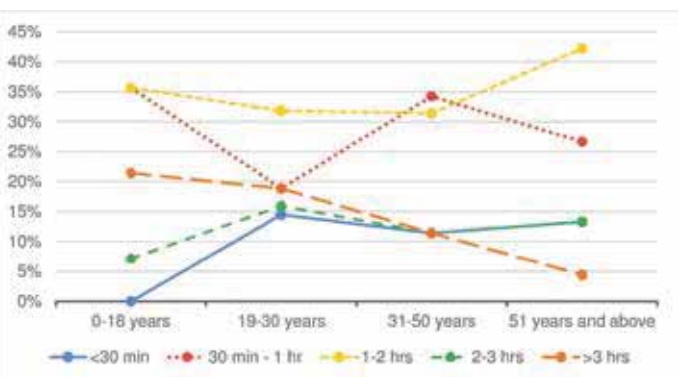

Figure 7: Time spent on online platforms for social interaction
Source: Authors

On the other hand, offline interactions provided mental joy and satisfaction as participants met their friends/relatives in person. A collective average of 89.5% participants across all age groups said non-verbal cues such as facial expressions, touch and voice modulations played an important role in social interactions (Figure 8). They also believe that close relationships grow through in-person interactions as they bring warmth and make conversations meaningful. Older adults feel the younger generations are missing the warmth, affection and joy experienced in face-to-face interactions.

64.3% adolescents held in-person social interactions daily. Whereas, this percentage decreased to 20.3% for young adults, 8.6% for mid-aged adults and 4.4% for older adults. Young and middle-aged adults most preferably met their friends and/or relatives 1-2 times a week for social interaction. But in the case of older adults, this frequency ranged between 1-2 times a week to 1-2 times a month. Another important factor is the type of conversation made and its influence on the mode of interaction preferred for the same. We noted that online modes of interaction were mostly preferred for general and formal interactions (Figure 9).

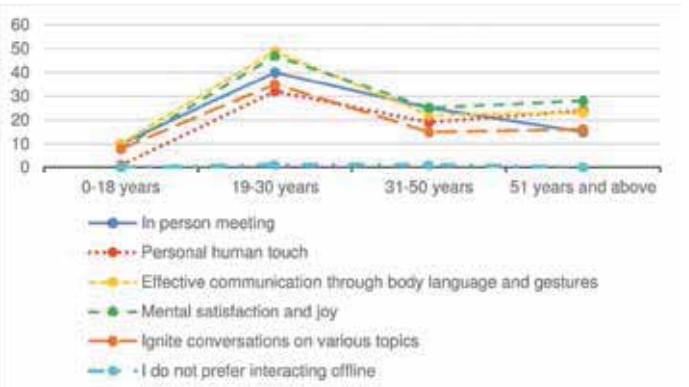

Figure 8: Reasons for preferring offline mode for interaction (through physical meeting)
Source: Authors

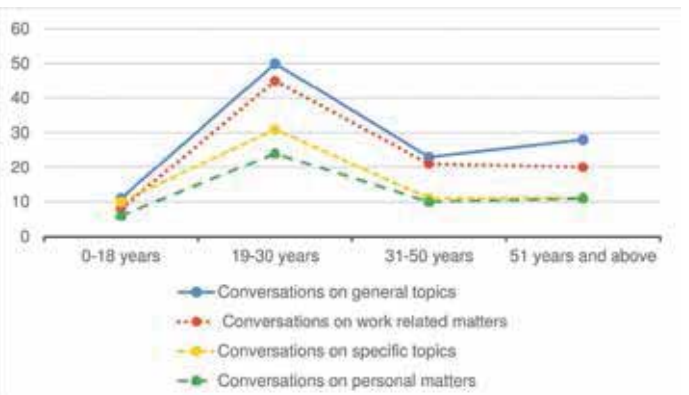

Figure 9: Types of conversations in online interactions
Source: Authors

Whereas participants preferred in-person meetings for discussions involving personal matters (Figure 10). It is interesting to note that most of the conversations held by older adults are on general topics, irrespective of the mode.

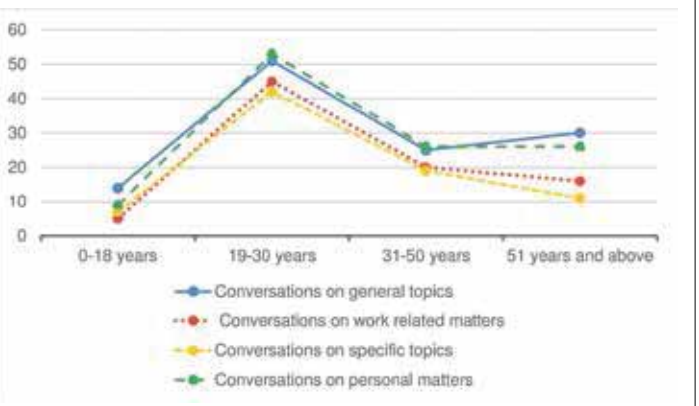

Figure 10: Types of conversations in offline interactions
Source: Authors

4.3 Built environment

The first two themes identified the intangible attributes and quality of interactions. The third theme identifies the role of physical place and spatial experience in socializing. In our survey, a collective average of 29.9% participants said that interactions held online may be as effective as in-person interactions. A collective average of 47.9% participants answered firmly that online interactions were not as effective as in-person interactions. Moreover, 71.8% participants across all age groups responded that the built environment played a role in promoting interactions.

It was noted that home, eateries, parks, malls, cafes, religious places, movie theatres and associations/ community centers were mostly preferred for socializing and interacting. But participants also used clubs, sports arenas, events, expos and outdoor activity areas like trekking for socializing. Furthermore, we found that children and adolescents also consider schools and colleges as potential social interaction places.

5. Discussion

The findings of this study provide insights into understanding the two predominant modes of social interaction, online and offline, the reasons for which they were preferred, and which mode was more desirable. Additionally, it makes an effort to determine the need for physical informal spaces in urban areas. In our study, we found that as the age of participants increased, they tended to form new connections in physical informal settings.

Young (19-30 years) and middle-aged (31-50 years) adults highlighted the importance and role of offline interactions in improving discipline and moral values, stating that in-person interactions provided an opportunity to explore oneself, which aided in creating a strong personality. Moreover, participants from the same age groups also recognized the relevance of these in-person interactions in the current time, indicating that online culture is causing disconnects in relationships and family values.

In our study, we also observed that 43% adolescents and 38% young adults felt a stronger sense of belonging in physical informal places. Online socializing platforms gave participants an opportunity for passive engagement and provided a sense of anonymity. But at the same time, there were also high chances of ambiguity involved in understanding the sincerity and true emotions of the other side. Due to such reasons, the interactions made online gave an impression of being disconnected from reality to a small percentage of participants.

The majority of mid-aged and older adults spent the same amount of time per day on online platforms for social interaction as adolescents and young adults did, contrary to the notion that the latter are often engaged in digital media. We observed that a very small percentage (4.4%) of older adults held in-person interactions daily. And despite the notion of being retired post the age of 60 years (in case of salaried people), and having more free time compared to young and mid-age adults, the in-person meeting frequency of older adults was less. This can be attributed to the decrease in the level of independence due to declining health conditions. The restrictions in movement are increasing dependency on others, leading to lower frequency of outdoor visits and thereby increasing dependency on online platforms. Adolescents recorded the highest frequency of in-person social interactions among the four age groups.

We noticed that participants across all age groups used online platforms for immediate and global connectivity, but most of their conversations were restricted to general topics and work-related matters. For discussing personal matters, they preferred face-to-face interactions as there was a possibility to understand cues through body language and gestures, and there was mental satisfaction and joy associated with it. Aligning with the study conducted by Nadizti et al. (2021), our findings showed that the built environment played a role in promoting interactions. For some of the attributes and quality of interactions, participants related to both online socializing platforms and physical, informal places. But upon analyzing closely, and comparing between the two modes, we found that for all three themes, the responses leaned positively towards physical informal places, irrespective of age groups.

While participants across all age groups used online platforms for interacting on a daily basis, they unanimously agreed that online interactions were not as effective as in-person interactions. Apart from traditional places, we identified other places that are being used for social interaction regularly in the present time. The newer places are mostly activity-specific, where people meet due to common interests. Certain places identified by the participants for social interactions, such as eateries, parks, religious centers and local theatres, are present and can be accessed at the neighborhood level. Whereas malls, clubs, sports arenas, and, to some extent, cafes, have a reach beyond the neighborhood and draw crowds from all over the city. While urban areas offer a wide range of informal social spaces, they must be located at the neighborhood level. This makes them more close-knit when compared to the latter.

6. Conclusion

Our research shows that though online platforms were used more often by the participants for social interactions, regardless of age groups, the interactions held in physical informal places were consistently valued more with respect to each attribute and quality. This shows the willingness of participants to interact in physical informal places, especially in the present time when digitalization is at its peak. It also highlights the need for such physical informal places, where people can gather regularly for casual interactions and build stronger social bonds.

While the study includes participants across all age groups, it does not focus on their socio-economic backgrounds. Likewise, gender is another factor that can be considered as a key parameter for the study. Also, the study considered participants only from metropolitan areas. Further research can be conducted to find whether the socio-economic backgrounds of people dictate the choice of mode used for socializing. Apart from that, participants from urban areas other than metropolitan areas can be included to find out whether the types of physical informal spaces differ from those mentioned in the study. Also, the cultural backgrounds of people and their influence on the choice of mode and places of social interaction can be considered, as some cultures have gender specific spaces for socializing.

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RESEARCH PAPER

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IEQ Assessment of Naturally Ventilated Hospitals in Ernakulam

By Ar. Anjali P and Ar. Arun Balan Urumban

Abstract

This research identifies the crucial aspects of Indoor Environmental Quality (IEQ) in naturally ventilated hospitals in Kochi, emphasising the need for sustainable healthcare environments. The primary objective is to evaluate the current state of IEQ in these hospitals and propose actionable solutions to enhance it. The study employs comprehensive onsite measurements of various IEQ parameters, including air quality, temperature, humidity and pollutant levels, to assess their compliance with established standards. The methodology involves detailed onsite data collection and analysis to understand the impact of natural ventilation systems on the health and well-being of hospital occupants. Key findings reveal that a significant portion of the measured IEQ parameters fall below acceptable standards, indicating a pressing need for remedial actions. The research identifies poor air quality and inadequate pollutant control as major concerns that compromise the indoor environment's suitability for patients and healthcare professionals. To address these issues, the research proposes innovative solutions such as the implementation of green walls, which utilise the natural air-purifying abilities of plants to improve indoor air quality and create a calming atmosphere. Additionally, the study recommends strategic replacement of building materials with those that better mitigate pollutants, enhancing the overall indoor environment. These proposed measures are practical, targeted and tailored to the specific needs of naturally ventilated hospitals. By addressing the identified shortcomings in IEQ, this research contributes to the discourse on sustainable healthcare infrastructure. The insights presented advocate for integrating natural elements and strategic material choices in hospital design, ultimately promoting healthier environments for both patients and healthcare professionals. This research underscores the importance of immediate and effective interventions to improve IEQ in healthcare settings, advancing the pursuit of sustainable and health-promoting hospital environments.

Keywords: IEQ assessment, Hospital building, Indoor Air Quality (IAQ), Human comfort, Occupant wellbeing.

1. Introduction

Indoor Environmental Quality is a critical aspect of building design and construction that focuses on the quality of the indoor environment in which people live, work and play. The primary factors that contribute to IEQ include thermal comfort, indoor air quality, visual comfort and acoustic comfort (Mujan, 2019; Tang, 2020). The quality of the indoor environment has a significant impact on the health, comfort and productivity of occupants (Mujan, 2019; Bluyssen, 2021). Studies have shown that changes in one environmental factor can impact the perception of other factors, highlighting the complex interactions between these different elements (Tang, 2020). Achieving an optimal indoor environment requires a comprehensive approach that considers the various IEQ factors and their interrelationships (Kraus, 2020). Adaptability is also closely related to health, comfort

and productivity, as occupants must be able to adjust to changes in the indoor environment (Kraus, 2020). Interestingly, the importance of IEQ has been recognised for centuries. Benjamin Franklin, the renowned American statesman and inventor, was an early advocate for improving indoor air quality. In his essay "Observations Concerning the Increase of Mankind, Peopling of Countries, etc.," Franklin discussed the negative health effects of poor indoor air quality, particularly in crowded living spaces. Franklin recognised the need for proper ventilation and air circulation to maintain a healthy indoor environment, highlighting the enduring relevance of IEQ considerations (Esfandiari, 2017; Kraus, 2020; Tang, 2020; Bluyssen, 2021). As the built environment continues to evolve, the importance of IEQ will only become more pronounced. Designers, builders and policymakers must work together to ensure that the indoor environments we create are conducive to the health, comfort and productivity of the occupants.

1.1 Aim

To assess the indoor environmental quality (IEQ) for naturally ventilated hospitals at Kochi, Ernakulam district

1.2 Hypothesis

- The IEQ of naturally ventilated hospitals in Kochi, Ernakulam district, differs significantly from the IEQ standards recommended for healthcare facilities.
- Naturally ventilated hospitals in Kochi, Ernakulam district, experience higher indoor temperatures and humidity levels during the summer months, negatively impacting the thermal comfort of patients and staff.

1.3 Objectives

General Objective:

- To evaluate the Indoor Environmental Quality of naturally ventilated hospitals in Kochi, Ernakulam district, focusing on key parameters such as thermal comfort, indoor air quality and lighting conditions.

Specific Objectives:

- To measure and analyse the thermal comfort levels within naturally ventilated hospital wards in Kochi, Ernakulam district, during different times of the day.
- To assess the indoor air quality by measuring and comparing the concentrations of key pollutants (e.g., PM2.5, CO2, VOCs) against recommended health-based guidelines.
- To evaluate the daylighting conditions by measuring illuminance levels at various locations and comparing them to recommended standards for healthcare facilities.
- To compare the measured IEQ parameters with standards.
- To develop recommendations for improving the IEQ, based on the research findings, considering both design and operational strategies.

1.4 Scope

- IEQ Parameters: The study will primarily assess thermal comfort, indoor air quality and lighting conditions. These parameters will be measured and analysed against relevant Indian and international standards for healthcare facilities.
- The research will be limited to hospitals that primarily rely on natural ventilation strategies for indoor air circulation. This may include older hospitals designed for natural ventilation and newer facilities incorporating hybrid ventilation systems.
- The study will be confined to hospitals situated within the Ernakulam district of Kochi, Kerala. This specific geographical focus allows a detailed analysis of IEQ considering the local climate, building practices and user needs.

1.5 Limitations

- The research will not cover other aspects of building performance, such as energy efficiency or water conservation, unless directly related to IEQ.
- The study will not extend beyond the geographical boundaries of the Ernakulam district in Kochi.
- The study considers seasonal variations in climate and their potential impact on IEQ.
- Access to photography, interviews and night visits was limited by the hospital management due to privacy issues.

2. Literature Review

2.1 Introduction to IEQ

In recent decades, understanding and managing Indoor Environmental Quality (IEQ) has become paramount due to its profound impact on occupants' health and well-being. Benjamin Franklin's shift in perspective from viewing fresh air as an adversary to embracing it as essential highlights the historical evolution in recognising the significance of ventilation. IEQ is a crucial aspect of building performance, as it

directly impacts the health, comfort and productivity of occupants (Sari, 2019). The emergence of Sick Building Syndrome (SBS) further underscored the complexities involved, attributing symptoms to a combination of factors such as chemical pollutants, inadequate ventilation and psychological stressors. This paradigm shift has elevated the importance of IEQ assessment in contemporary built environments. With hospitals in Ernakulam as the focal point, this research aims to evaluate and improve IEQ, encompassing factors like thermal comfort, indoor air quality, acoustic and visual comfort and other crucial aspects to enhance patient outcomes and staff well-being. Particularly in the healthcare sector, where patients and staff alike spend extended periods within the facility, maintaining a high level of indoor environmental quality is paramount (Sari, 2019). This research aims to evaluate the indoor environmental quality of a hospital building located in Ernakulam, Kerala, to identify areas for improvement and provide recommendations to enhance the overall occupant experience. The indoor environment of a healthcare facility encompasses various factors, including air quality, thermal comfort, lighting and acoustics (Alfa, 2019). Previous studies have highlighted the significance of these factors in shaping occupant perception and well-being (Sari, 2019). This research delves into the assessment of these components within the Ernakulam hospital, with a focus on their influence on the health and satisfaction of both patients and staff (Alfa, 2019).

2.2 Impact of Poor IEQ on Patients, Staff and Operational Costs

The importance of maintaining a healthy indoor environment in healthcare facilities cannot be overstated. Poor IEQ can have significant consequences for both the occupants and the operational efficiency of the building. Patients are directly impacted by the quality of the indoor environment, as it can affect their healing process and overall well-being. A hospital environment that contributes to healing not only adds to the patient's well-being but also to the well-being of the healthcare workers. As such, the indoor environmental quality of a hospital facility is essential for its occupants, as a poor-quality environment can create stressful feelings and negatively impact the occupants' perception of their surroundings. The hospital staff is also directly affected by the indoor environmental quality, as they spend a significant amount of time in the building each day. The acoustic environment, ventilation and air conditioning systems, thermal environment, visual environment, ergonomic conditions and furniture can all have beneficial or detrimental effects on the health and well-being of the staff, which in turn impacts their ability to provide high-quality care to patients (Salonen, 2013; Sari, 2019). Moreover, poor indoor environmental quality can lead to increased operational costs for the healthcare facility. Factors such as temperature, humidity and air quality can impact the efficiency of the mechanical systems, leading to higher energy consumption and maintenance costs. Additionally, a building that is not designed to accommodate the needs of its occupants can result in increased absenteeism, staff turnover and patient complaints, all of which can have a significant financial impact on the organisation. In conclusion, the impact of poor indoor environmental quality in healthcare facilities is far-reaching, affecting the patients, staff and operational costs. Healthcare facilities must prioritise the design and maintenance of a healthy indoor environment to ensure the well-being of their occupants and the overall efficiency of the organisation.

2.3 Sick Building Syndrome (SBS)

The modern hospital environment, with its high-tech equipment, artificial lighting and synthetic materials, can have a significant impact on the health and well-being of both patients and staff. SBS, a term coined by the World Health Organization, is a growing concern in the healthcare sector. There are studies suggesting that up to 30% of buildings are prone to such issues and an additional 30% are likely to develop similar symptoms (Vitel, 2001). One of the primary factors contributing to SBS in hospitals is poor indoor air quality. Inadequate ventilation, high concentrations of carbon dioxide and humidity levels can all trigger the onset of symptoms, which can include irritation of the nose, throat and eyes, as well as headaches and feelings of lethargy (Dennis, 1998). These issues can have a direct impact on the productivity and morale of healthcare workers, as well as the overall well-being of patients. In addition to air quality, the selection of building materials and the design of the physical environment can also play a significant role in the prevalence of sick building syndrome. The off-gassing of chemicals from certain materials, as well as the growth of molds and bacteria, can contribute to the deterioration of indoor environmental quality (Kubba, 2016). To address these challenges, healthcare facilities must adopt a holistic approach to indoor environmental quality management. This includes the selection of low-emitting materials, the implementation of appropriate ventilation strategies and the provision of adequate access to natural lighting and views (Kubba, 2016). By addressing the root causes of sick building syndrome in hospitals,

healthcare organisations can not only improve the overall health and well-being of their staff and patients but also enhance the productivity and efficiency of their operations.

2.4 IEQ Parameters

The IEQ of hospitals is a critical factor in ensuring the well-being and comfort of both patients and healthcare professionals. Hospitals are unique environments that require special consideration to maintain a healthy indoor air quality (Sari, 2019). A hospital environment that contributes to healing not only adds to the patient's wellbeing but also the wellbeing of the healthcare workers (Alfa, 2019).

One of the key IEQ parameters in hospitals is thermal comfort (Alfa, 2019). Maintaining a comfortable temperature and humidity range is essential for patient recovery and staff productivity. Hospitals often need to balance the need for positive air pressure in some areas to protect patients from airborne infectious agents with the need for negative air pressure in other areas to contain the spread of contaminants (Shajahan, 2019). Additionally, air quality is a crucial factor in hospital IEQ (Sari, 2019; Shajahan, 2019). Hospitals must ensure adequate ventilation and filtration to remove pollutants, allergens and infectious agents from the indoor air. Lighting is another important IEQ parameter, as proper lighting can improve patient outcomes, reduce medical errors and enhance staff performance (Assoumou, 2022; Alfa, 2019). Noise levels in hospitals can also have a significant impact on patient recovery and staff well-being (Alfa, 2019; Assoumou, 2022). Excessive noise from equipment, conversations and other sources can disrupt sleep, increase stress and hinder the healing process. In summary, the key IEQ parameters relevant to hospitals include thermal comfort, air quality, lighting and noise control. Hospitals must carefully design and maintain their indoor environments to support the health and well-being of patients, visitors and staff (Sari, 2019; Alfa, 2019; Shajahan, 2019; Assoumou, 2022)

2.4.1 Indoor Air Quality (IAQ)

Maintaining a healthy indoor air quality is a crucial aspect of ensuring the well-being of patients, staff and visitors within hospital environments. Poor indoor air quality can have significant adverse effects on the occupants, including increased susceptibility to illnesses, reduced productivity and compromised overall health (Kubba, 2016; Alfa, 2019).

One of the key factors contributing to indoor air quality is the concentration of various pollutants, such as carbon monoxide, formaldehyde, total volatile organic compounds and particulate matter. These pollutants can originate from a variety of sources, including off-gassing from building materials, occupant activities and infiltration of outdoor air pollution (Kubba, 2016; Clements, 2018). To optimise the indoor air quality in hospitals, it is essential to maintain the desired levels of these pollutants. The recommended levels (Table 1) for carbon monoxide, formaldehyde, total volatile organic compounds and particulate matter (PM2.5) in hospital environments are typically less than 9 ppm, less than 0.1 ppm, less than 500 µg/m³ and less than 25 µg/m³, respectively (Yusup, 2014; Kubba, 2016; Alfa, 2019). Furthermore, maintaining appropriate humidity levels, typically between 30% and 60%, is crucial for the health and comfort of the occupants (Kubba, 2016; Alfa, 2019). By ensuring that the indoor air quality in hospitals meets these standards, healthcare facilities can create an environment that supports the healing process, enhances the well-being of patients and promotes the productivity and efficiency of healthcare workers (Esfandiari, 2017; Alfa, 2019)

Table 1: Different values of IAQ parameters according to standards
Source: WHO, ASHRAE, IS CODES, IGBC, ISHRAE

Values for Indoor Air Quality						
Parameters	Unit	WHO	ASHRAE	IS CODES	IGBC	ISHRAE
PM 10	µ/m3	50	50	50	50	<100
PM 2.5	µ/m3	25	15			25
VOC	µ/m3	600		300	500	500
CO	ppm	9 (mg/m3)	9		9	<9
HCHO	µ/m3	100 (0.08 ppm)		50	50	100
CO2	ppm	1520 (2250mg/m3)		1000		ambient+700

2.4.2 Thermal comfort

Providing thermal comfort in hospital settings is a critical consideration that directly impacts the well-being and recovery of patients, as well as the overall productivity and satisfaction of healthcare professionals. Hospitals, with their diverse occupancy profiles and varying medical requirements, face unique challenges in maintaining an optimal thermal environment that caters to the needs of all stakeholders (Rahman, 2021). Existing literature highlights the importance of addressing thermal comfort in naturally ventilated hospital wards, particularly in tropical climate countries (Rahman, 2021). The primary goal is to strike a balance between energy efficiency and thermal comfort, ensuring that patients and staff experience a comfortable indoor environment without compromising the sustainability and cost-effectiveness of the facility (Yau, 2013; Alsaleem, 2020). Table 2 details the ISHRAE standards for temperature & humidity.

2.4.3 Visual Comfort

Lighting plays a crucial role in the overall well-being and productivity of individuals in various settings and hospitals are no exception. The design of lighting systems in healthcare facilities must consider several factors to ensure optimal visual comfort and support the diverse needs of patients, staff and visitors (Salonen, 2013).

The physical characteristics of the indoor environment, including lighting, can have a significant impact on health and well-being in healthcare facilities (Salonen, 2013). Appropriate lighting levels and distribution are essential for creating a therapeutic atmosphere that promotes successful treatment and stress alleviation (Khaleghimoghaddam, 2023). Research has shown that higher illuminance levels can influence subjective alertness and provide higher levels of vitality, leading to better performance and improved well-being (Öner, 2020). However, it is important to note that higher light intensities can also produce visual discomfort, such as glare, which may inhibit individuals from performing tasks effectively (Öner, 2020). The appropriate lighting for any given situation must be determined after a thorough analysis of the specific tasks and the individual's needs (Summers, 1989). In healthcare settings, lighting should be tailored to accommodate the diverse needs of patients, staff and visitors. For example, patients may require higher lighting levels for reading or performing tasks, while staff may need lower lighting levels for tasks that require visual concentration, such as examining patients or reviewing medical records. ISHRAE standards for illuminance are mentioned in Table 3.

2.4.4 Acoustic comfort

Hospitals often face the challenge of providing a comfortable and conducive environment for patients, staff and visitors. One critical aspect of this challenge is the acoustic environment, which can have a significant impact on the overall well-being and recovery of patients (Wang, 2013; Lombardo, 2013). Acoustic comfort in hospitals is a crucial component of the overall patient experience. Patients in intensive care units are exposed to various sources of discomfort, many of which are related to the patient's condition. However, the design and organisation of the hospital environment can also contribute to acoustic discomfort, which can have a detrimental effect on the patient's psychological well-being and recovery process (Baker, 1992). Hospitals should strive to create an acoustic environment that minimises stress and discomfort for patients, allowing

Table 2: Different values of Temperature & Humidity according to ISHRAE standards

Parameters	Units		Class A	Class B	Class C
Operative Temperature	°C	If air velocity >0.2	Table 3		
		If air velocity <0.2	Calculate using Chart m/s		
Relative Humidity	%		30-70	30-70	a. 30
Vertical Air Temperature	°C	Warm Ceiling	<7	-	-
		Cool Wall	<13	-	-
		Cool Ceiling	<18	-	-
		Warm Wall	<35	-	-
Floor Surface Temperature	°C		17	-	-
			31	-	-
Occupant Satisfaction	%		90	80	-

Table 3: Different values of Illuminance according to ISHRAE standards

Parameters	Units	Class A	Class B	Class C
Illuminance				
Circadian Lighting	Equivalent Melanopic Lux	At least 240 EML in regularly occupied spaces, through electric light only	At least 150 EML in regularly occupied spaces, through electric light only	
Uniformity of Illuminance at Task		0.7	0.7	0.7
Uniformity of Illuminance in the immediate surrounding area		0.5	0.5	0.5
Illuminance in the immediate surroundings		As per the above table		
Percentage of the workstations meeting the required illuminance at the task place	%	100	90	90
Occupant satisfaction	%	90	80	-
Controllability of the lighting environment		Yes	Yes	No

them to feel more competent and independent as they navigate the healthcare system (Baker, 1992). Acoustic comfort is not only beneficial for patients but also for healthcare workers, as a well-designed hospital environment can enhance their efficiency and well-being (Alfa, 2019). Various standards are available for the desirable sound levels (Table 4).

2.4.5 Olfactory comfort

The human olfactory system is a complex and intricate network that plays a crucial role in our daily lives, influencing our emotions, memories and overall well-being. Contrary to the commonly held belief that olfaction is a less prominent sense compared to vision or audition, recent research has revealed the profound impact of scents on our physiological and psychological states.

Olfaction, often overlooked in formal codes and quantitative measurements, is a sense that elicits deeply personal and qualitative experiences. The ability to evoke emotions, memories and even physiological responses through the sense of smell is a testament to the profound connection between the olfactory system and the limbic system, the emotional center of the brain. Olfactory cues can trigger a range of physiological responses, such as changes in skin conductance, pulse frequency and breathing patterns, as well as variations in biochemical markers like cortisol levels. The emotional and memory-inducing nature of olfaction can be particularly influential in the context of traditional restaurants, where the overall dining experience is heavily reliant on the sensory environment. Olfactory cues, such as the aroma of freshly baked bread or the fragrance of herbs and spices, can significantly contribute to a customer's satisfaction and overall perception of the establishment. Similarly, in captive audience settings like hotels, retail showrooms and casinos, the strategic use of scent-based systems can create a memorable and emotionally engaging experience

Table 4: Different values of desirable sound according to standards
Source: IS 3483-1965, Noise regulation, G7T 1883- 2002

Acoustic Comfort				
Activity	**Unit**	**IS 3483-1965**	**Noise Regulation Commercial Building**	**G7T 1883-2002**
Common spaces	dB	82-95	70-75	50

Table 5: Different values of IEQ parameters of hospital A-9:30 am to 10:30 am

Time: Morning Session: 9:30 AM – 10:30 AM											
Parameters	**Unit**	**Readings**									
		Pharmacy Waiting Area	**Lobby**	**Administration**	**Waiting Area**	**Lab Collection Centre**	**Washroom Lobby**	**Corridor cum waiting**	**Corridor/ Waiting**	**Cardiology Dept. Waiting Area**	**Cath Lab Waiting**
Thermal Comfort											
Temperature	^{o}C	30.1	30.8	30.9	31.3	31.9	31.7	32	31.7	31.8	31.4
Humidity	%	75	66	69	78	65	67	67	63	66	65
Air Velocity	m/s	0.6	1.5	0.4	0.4	0.5	0.1	0.4	0.9	0.6	0
Air Quality											
HCHO	mg/m3	160	148	154	164	170	160	170	170	163	163
PM2.5	mg/m3	10	13	10	10	10	8	10	8	8	8
TVOC	mg/m3	11	13	13	12	11	10	11	9	9	0
CARBON	ppm	8	7	6	7	7	6	6	6	7	4
Acoustics											
Sound	dB	73.4	73.9	72.5	68.7	72.7	65.7	73.5	74.2	76.8	70
Illumination											
Light Level	Lux	463	681	354	159	88	198	336	275	153	76

Table 6: Different values of IEQ parameters of hospital A-1:30 pm to 2:30 pm

Time: Noon Session: 1:30 PM to 2:30 PM											
Parameters	Unit	**Readings**									
		Pharmacy Waiting Area	**Lobby**	**Administration**	**Waiting Area**	**Lab Collection Centre**	**Washroom Lobby**	**Corridor cum waiting**	**Corridor/ Waiting**	**Cardiology Dept. Waiting Area**	**Cath Lab Waiting**
Thermal Comfort											
Temperature	^{o}C	31.5	31.8	31.8	31.5	31.9	31.9	31.8	31.8	32.2	31.5
Humidity	%	66	62	63	64	66	63	65	62	61	63
Air Velocity	m/s	0.4	0.6	0.4	0.4	0.4	2	0.4	0.8	0.6	0.4
Air Quality											
HCHO	mg/m3	168	172	162	164	169	168	168	172	172	163
PM2.5	mg/m3	9	10	8	9	8	7	7	5	7	10
TVOC	mg/m3	10	9	9	0	9	8	9	6	9	11
CARBON	ppm	7	7	7	7	6	8	10	7	6	4
Acoustics											
Sound	dB	71.2	73.4	72.5	71.3	78.7	65.4	72.4	72.4	71.3	67.3
Illumination											
Light Level	Lux	1250	990	252	122	43	223	100	245	179	80

Table 7: Different values of IEQ parameters of hospital A-5:00 pm to 6:00 pm

Time: Evening Session: 5:00 PM to 6:00 PM											
Parameters	Unit	**Readings**									
		Pharmacy Waiting Area	**Lobby**	**Administration**	**Waiting Area**	**Lab Collection Centre**	**Washroom Lobby**	**Corridor cum waiting**	**Corridor/ Waiting**	**Cardiology Dept. Waiting Area**	**Cath Lab Waiting**
Thermal Comfort											
Temperature	^{o}C	29.4	29.8	30	30	30.7	30.8	30.5	31.1	31.1	31.1
Humidity	%	77	66	65	64	64	66	64	66	77	66
Air Velocity	m/s	0.5	0.5	0.4	0.4	0.4	2	0.6	0.7	0.6	0.3
Air Quality											
HCHO	mg/m^3	168	170	170	170	170	172	156	169	169	169
PM2.5	mg/m^3	10	11	12	12	10	11	10	10	10	8
TVOC	mg/m^3	11	13	13	11	12	12	11	10	11	9
CARBON	ppm	7	6	7	6	7	7	7	6	7	4
Acoustics											
Sound	dB	69.2	70.5	71.9	70.4	46.6	66.3	71.9	71.9	72.4	69.4
Illumination											
Light Level	Lux	514	332	160	162	80	183	402	358	104	187

Table 8: Different values of IEQ parameters of hospital B -9:30 am to 10:30 am

Hospital B -Morning Session: 9:30 AM to 10:30 AM									
Parameters	Unit	**Readings**							
		Waiting Area – Sheet Roof Concrete Flooring	**Waiting Area Pediatric OP**	**Lab Waiting Area**	**Waiting Area Cum Corridor**	**Canteen**	**Outdoor Entrance (Pharmacy/ Café)**	**Corridor**	**New Block Waiting Area**
Thermal Comfort									
Temperature	^{o}C	30.9	30.5	30.8	30.2	31	28.8	30.9	31.4
Humidity	%	77	71	69	71	71	68	69	67
Air Velocity	m/s	0.4	0.3	0.2	0.6	2	0.4	0.4	
Air Quality									
HCHO	mg/m^3	168	170	166	166	173	155	160	172
PM2.5	mg/m^3	13	14	46	46	11	20	45	10
TVOC	mg/m^3	8	8	6	9	11	11	12	6
CARBON	ppm	7	7	10	10	9	10	10	10
Acoustics									
Sound	dB	74	71.9	74.7	75.5	78.5	70.2	66.6	70.8
Illumination									
Light Level	Lux	348	128	172	51	166	765	706	86

Table 9: Different values IEQ parameters of hospital B -1:30 PM to 2:30 PM

Hospital B -Noon Session 1:30 PM to 2:30 PM									
Parameters	Unit	**Readings**							
		Waiting Area – Sheet Roof Concrete Flooring	**Waiting Area Pediatric OP**	**Lab Waiting Area**	**Waiting Area Cum Corridor**	**Canteen**	**Outdoor Entrance (Pharmacy/ Café)**	**Corridor**	**New Block Waiting Area**
Thermal Comfort									
Temperature	^{o}C	29.6	30.9	31.2	31.1	31	31	31.4	31.6
Humidity	%	74	73	72	69	69	68	67	69
Air Velocity	m/s	0.3	0.3	0.3	0.6	2	0.4	0.4	
Air Quality									
HCHO	mg/m^3	173	174	172		176	158	134	173
PM2.5	mg/m^3	11	8	22	172	9	11	10	9
TVOC	mg/m^3	7	8	7	5	9	9	9	9
CARBON	ppm	7	9	9	9	7	9	8	7
Acoustics									
Sound	dB	84.7	75.2	67.2	82.5	71.1	90.1	69.7	74.4
Illumination									
Light Level	Lux	485	84	123	250	65	714	518	278

Table 10: Different values of IEQ parameters of hospital B -5:00 PM to 6:00 PM

Hospital B -Evening Session 5:00 PM to 6:00 PM									
Parameters	Unit	Readings							
		Waiting Area – Sheet Roof Concrete Flooring	Waiting Area Pediatric OP	Lab Waiting Area	Waiting Area Cum Corridor	Canteen	Outdoor Entrance (Pharmacy/ Café)	Corridor	New Block Waiting Area
Thermal Comfort									
Temperature	^{o}C	31.1	31.2	31.2	31.2	31	31	31.2	31.2
Humidity	%	71	16	69	71	71	70	69	69
Air Velocity	m/s	0.3	0.2	0.2	0.6	2	0.4	0.4	
Air Quality									
HCHO	mg/m^3	166	164	170	170	172	164	173	173
PM2.5	mg/m^3	14	12	9	10	10	11	9	10
TVOC	mg/m^3	8	8	7	7	7	7	9	7
CARBON	ppm								
Acoustics									
Sound	dB	69.3	74.6	65.4	68.4	34.2	78.7	64.5	71.3
Illumination									
Light Level	Lux	271	249	131	24	44	168	279	145

for consumers, fostering a deeper connection with the brand (Ilapakurti, 2017)Furthermore, the communicative function of body odors, often underestimated, can convey a wealth of social information, ranging from gender to emotional states (Groot, 2017). Understanding the nuances of olfactory communication can provide valuable insights into the complex interplay between the senses, emotions and social interactions. While the quantitative aspects of olfaction have been the focus of many studies, the qualitative dimensions of olfactory comfort and their impact on human well-being deserve greater attention (Buettner, 2015; Silaban, 2023). By exploring the nuanced and personal nature of olfactory experiences, researchers can gain a deeper understanding of the multifaceted role of the sense of smell in our lives and uncover new avenues for enhancing individual and societal well-being.

3. Methodology

This study (Figure 1) will adopt a mixed-methods approach, combining quantitative data from on-site measurements of IEQ parameters with qualitative data gathered through observations and potentially interviews or surveys. This approach will provide a comprehensive understanding of the existing IEQ conditions and their implications. In this chapter, the comprehensive methodology employed to assess the Indoor Environmental Quality (IEQ) of naturally ventilated hospitals in Kochi has been outlined. The methodology was carefully designed to address the research question and objectives, focusing on the comfort and well-being of hospital occupants within the context of IEQ parameters. Through an extensive literature review, key IEQ parameters were identified, including IAQ, Thermal comfort, acoustic comfort, visual comfort and olfactory comfort. With these parameters, a mixed-methods approach was adopted, incorporating quantitative data collection and qualitative insights, holistically evaluating the IEQ conditions within the hospitals.

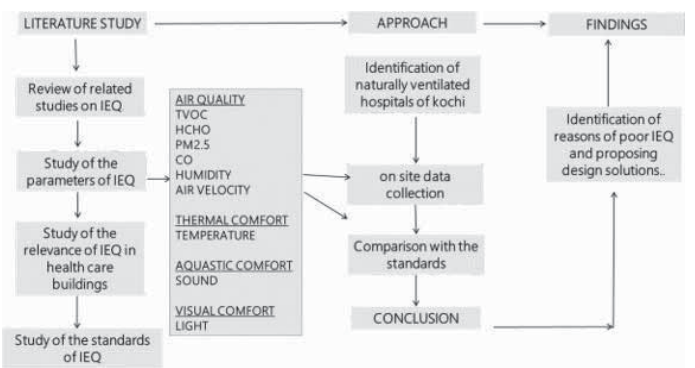

Figure 1: Methodology
Source: Author

Tools for data collection

Figure 2 shows the equipment used for IEQ measurements: a) Smile Drive, b) Anemometer, c) Carbon Meter, d) Temperature Humidity Clock, e) Lux Meter, f) DECIBEL meter.

Figure 2: Equipment used for measuring IEQ parameters
Source: Author

4. Data Analysis and Findings

This study focuses on assessing the Indoor Environmental Quality of hospital buildings located in Ernakulam district, with a particular emphasis on the impact of proximity to major roads and traffic junctions. To investigate this relationship, two hospitals in Ernakulam were purposefully selected for in-depth analysis. Both hospitals are situated in proximity to major roads and experience high traffic volumes, representing a common scenario in urban healthcare settings. This strategic selection allows for a focused examination of how traffic-related factors, such as noise and air pollution, might influence the IEQ within these healthcare facilities.

This study prioritises ground-floor waiting areas in the selected hospitals due to their high occupancy, diverse activities and prolonged exposure for a range of individuals, including vulnerable patients. Focusing on these spaces ensures both a representative sample of the hospital's public areas and a feasible approach to data collection. These easily accessible areas minimise disruption, offer a controlled environment for IEQ measurements and raise fewer ethical concerns compared to more sensitive hospital spaces. To capture potential fluctuations in IEQ parameters throughout the day, measurements will be taken three times daily within the selected waiting areas: Morning: 9:30 AM to 10:30 AM, Noon: 1:30 PM to 2:30 PM, Evening: 5:00 PM to 6:00 PM. This schedule is designed to align with peak occupancy periods in hospital waiting areas, ensuring the collected data reflects the IEQ conditions experienced by a significant number of occupants. The chosen times also consider logistical feasibility, minimising disruption to hospital operations and patient flow during critical periods like early mornings or late evenings.

Case 1- Hospital (A) (Figure 3)

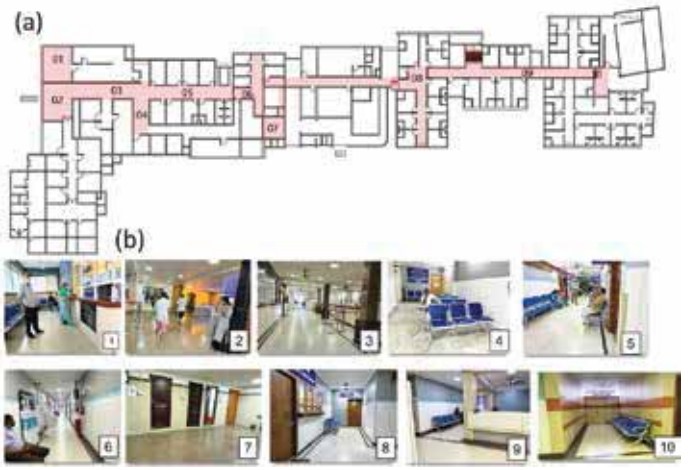

Figure 3: Case 1: Hospital A : (a) Ground Floor Plan (b) Interior Spaces where readings are taken: 1. Pharmacy waiting area, 2. Main lobby, 3. Administration lobby, 4. Waiting area, 5. Corridor waiting area, 6. Corridor cum waiting area, 7. Toilet lobby, 8. Lab collection area, 9. Cardiology department waiting area, 10. Cath lab waiting area
Source: Author

Case 2- Hospital (B) (Figure 4)

Figure 4: Hospital B: (a) Ground Floor Plan (b) Interior spaces where readings are taken: 1. Waiting area 2. Waiting area cum corridor 3. Waiting area -Pediatric OPD 4. Outdoor entrance lobby (pharmacy &café) 5. Corridor 6. Lab waiting area 7. Canteen
Source: Author

4.1. Analysis

Case 1: The IEQ assessment of the hospital reveals a concerning trend of inadequate indoor environmental quality across various departments. Waiting areas, in particular, emerge as significant areas of concern. The pharmacy, OP department, lab collection centre and cardiology waiting areas all suffer from poor air quality, likely aggravated by overcrowding during peak hours and compounded by insufficient ventilation. This is particularly worrisome in the cardiology department's waiting area, where poor air quality is coupled with high humidity, creating a stifling environment for patients already facing health challenges. Noise levels are also problematic, especially near the emergency ward, administrative zones and corridors, impacting both patient and staff comfort. The reliance on artificial lighting and mechanical systems like fans, especially in the cardiology waiting area, further underscores a lack of natural ventilation and its potential benefits to IEQ. Additionally, the washroom area presents concerns related to sanitation and olfactory comfort. These findings highlight an urgent need for targeted interventions to improve the hospital's IEQ, focusing on ventilation improvements, noise reduction strategies and optimisation of natural lighting to create a healthier and more comfortable environment for patients and staff.

Case 2: This analysis reveals concerning Indoor Environmental Quality issues across various sections of the hospital. Common problems include poor flooring materials leading to dust accumulation, inadequate ventilation causing poor air quality and high humidity and noise pollution from nearby roads. Specifically, the waiting area suffers from these issues, compounded by a problematic double-height sheet roof causing temperature variations. The waiting/corridor space, pediatric OP waiting area and entrance area all share concerns regarding flooring, noise and air quality. The canteen faces additional challenges with congestion and low lighting. The analysis stresses the urgency of implementing solutions like air filtration, low-VOC materials, improved HVAC systems, soundproofing, antimicrobial flooring and optimised natural lighting. Overall, a comprehensive approach emphasising material changes, ventilation enhancements and regular monitoring is crucial for achieving sustained IEQ improvements throughout the hospital.

5. Results and Discussion (Figures 5-7)

- Importance of IEQ: The study underscores the crucial role of Indoor Environmental Quality (IEQ) in healthcare facilities, particularly in naturally ventilated hospitals.
- Research Findings: Meticulous research and on-site measurements have revealed significant shortcomings in the existing IEQ parameters of the hospitals under study, emphasising the urgent need for improvements.
- After conducting a comprehensive study comparing IEQ factors such as materials, sound and air quality in two hospitals, it was observed that Lakshmi Hospital exhibited suboptimal conditions in these areas.

Figure 5: Thermal Comfort Parameter Results for Hospitals A and B
Source: Author

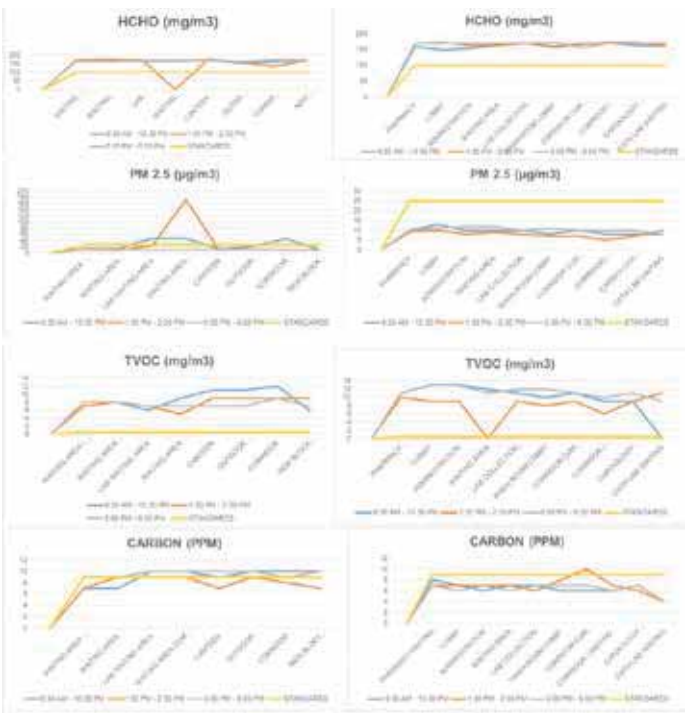

Figure 6: Air Quality Parameter Results for Hospitals A and B
Source: Author

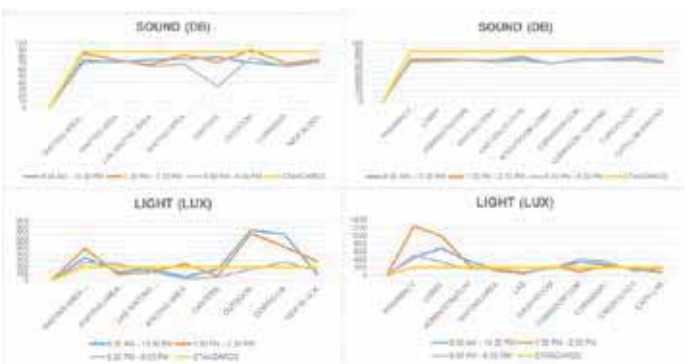

Figure 7: Acoustic and Illumination Parameter Results for Hospitals A and B
Source: Author

- Based on this analysis, it is imperative to address the deficiencies identified in Lakshmi Hospital's IEQ to ensure a healthier and more conducive environment for both patients and healthcare providers. Implementing thoughtful design recommendations tailored to improve materials, sound insulation and air quality in Lakshmi Hospital will not only enhance the well-being of its occupants but also contribute significantly to the overall healthcare experience.
- By prioritising these aspects in the hospital's design, we can create a space that promotes healing, comfort and optimal performance

6. Conclusions and Recommendations

An alarming departure from accepted norms was found when the indoor environmental quality of hospitals in Ernakulam that are naturally ventilated was assessed. The majority of the important factors, including ventilation, air quality and thermal comfort, were found to be below the recommended standards by the study. The insufficient thermal comfort that patients and visitors experience is one of the main issues. The study shows that these hospitals' interior temperatures are below the recommended levels in the area, which raises the possibility of a discrepancy between the residents' preferred temperatures and the real environment. This disconnection may have detrimental effects on patients' health and recuperation, as well as the comfort of guests and employees. Moreover, it has been discovered that the air quality in these naturally ventilated hospital wards is not at its best. An assessment of the interior environmental quality of naturally ventilated hospitals in Ernakulam revealed a concerning deviation from established limits.

The study indicated that most of the significant parameters, including ventilation, air quality and thermal comfort, were below the recommended standards. One of the primary problems is the inadequate thermal comfort that both patients and visitors encounter. According to the study, the interior temperatures of these institutions are lower than the local recommendations, which increases the likelihood that residents' preferred temperatures and the actual environment may differ. An evaluation of the internal environmental quality of naturally ventilated hospitals in Ernakulam has revealed a concerning deviation from recommended standards. The majority of the important metrics, including ventilation, air quality and thermal comfort, were found to be below the recommended levels, according to the study. The insufficient thermal comfort that both patients and visitors experience is

one of the main issues. The study finds that these institutions' interior temperatures are lower than what is recommended locally, which raises the possibility that residents' ideal temperatures and the real environment may differ.

Policy-level Recommendations

- Stringent Material Standards: Enforce strict guidelines for flooring, roofing and other construction materials to ensure they are low-VOC (Volatile Organic Compounds), non-toxic and easy to clean, reducing dust accumulation and promoting a healthier indoor environment.
- Noise Pollution Control: Implement regulations and standards to limit noise levels within and around hospital premises. This can involve soundproofing measures, green barriers and restrictions on noisy activities during specific hours.
- Air Quality Monitoring and Ventilation Standards: Mandate regular air quality assessments and ensure hospitals adhere to proper ventilation standards. Introduce guidelines for adequate air changes per hour, filtration systems and ventilation design to minimise indoor air pollutants.
- Infection Control Protocols: Develop and enforce stringent infection control policies, emphasising regular cleaning and disinfection of surfaces and air ducts, as well as appropriate waste management procedures to prevent the spread of diseases.
- Natural Lighting Requirements: Encourage hospital designs that maximise natural light penetration, promoting the use of skylights and large windows. Develop policies that prioritise natural lighting in patient rooms and common areas, enhancing both IEQ and patient well-being.
- Green Initiatives: Encourage hospitals to adopt eco-friendly practices, including green roofs, indoor plants and energy-efficient HVAC systems. Develop policies that support green building certifications, promoting sustainability and healthier indoor environments.

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STUDENT WORK

Salutogenic Approach to Design Healthcare Facilities

A Case of Budhani, Madhya Pradesh, India

By Urja Kaushal and Uphar Chandratre Guide: Ar. Vivek Sehgal

1. Introduction

The term *Salutogenesis* means "the origin of health," and shifts the focus from disease to factors that support human health and resilience. Hospitals are often treated as purely functional blocks, but in this project, the same narrative has been reimagined. Hence, the approach was not to design a hospital as a 'building', but as a system—one that breathes, connects and heals.

The project aims to create a space with principles of biophillic design, i.e., where nature is integrated in and around the building (refer Figure 1) and also providing culturally rich social spaces with sensory comfort. Efficient spaces have been designed for patients, doctors and staff, ensuring clarity and hygiene, while green terraces, courtyards and herbal gardens bring in a layer of calm and care. The result is a hospital that restores not just the body, but the human spirit.

Figure 1: Biophilic design visualised—integrating nature into every layer of the hospital campus

1.1 Concept and Ideology

The design manifests the idea that everyone in the building—patients, doctors, nurses and visitors—should feel an environment created to heal. The design fosters the need for an enclosed, sterile sanctuary for treatment, while also allowing the greatest healer – nature to intervene and promote the healing process. It strikes a thoughtful balance between a sterile, enclosed environment necessary for medical care and open, nature-integrated spaces that support emotional and psychological healing. Rooted in the philosophy of biophilic design, it creates a setting where nature and architecture coexist, enabling healing to occur on multiple levels.

1.2 About the site

The proposed 530-bedded hospital is in Budhani, District Sehore, Madhya Pradesh, near the sacred Narmada River and the Beejasan Devi Temple. Out of the total 16-hectare site allotted for the medical college campus, a dedicated 15-acre parcel was allocated for the teaching hospital. With excellent connectivity via the Bhopal–Narmadapuram highway and a composite climate, the site supports a context-sensitive, efficient and healing-driven healthcare design.

2. The Site Planning - Philosophy

The site embraces the natural and cultural richness of its location—a land of temples and mountains—by incorporating local materials and forms into the architectural language. A stepped healing garden, inspired by the surrounding terrain, serves as a

key therapeutic element for patients and visitors alike. Additionally, a waterbody within the site pays homage to the nearby Narmada River, offering a tranquil visual connection to nature (refer Figure 2). This setting is not only symbolic but also functional—patients and visitors can experience this natural view from waiting areas and patient rooms, reinforcing a sense of calm and connectedness. Together, these elements create a hospital that is both clinically efficient and culturally grounded—a place of care where the built environment supports both healing and heritage.

Figure 2: Narmada-inspired landscape softens the hospital's threshold with nature and form

3. Circulation at site level

Movement for emergency patients: The site has a direct visible approach route from the entry to the emergency department. The emergency department has dedicated parking for ambulances and other vehicles so that they do not obstruct the flow to the general entry and the out-patient department (OPD).

Movement for OPD patients/visitors: The road network is divided for the vehicles entering the site, the vehicles for parking and the vehicles leaving the site, leaving no traffic congestion or any two-way traffic within the site (refer Figure 3).

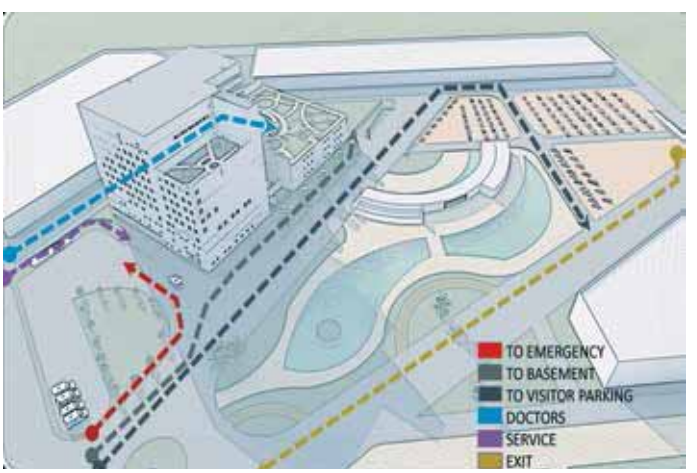

Figure 3: Conflict-free circulation for emergency, patients, doctors and services ensures smooth, efficient hospital movement

Movement for doctors and staff: The doctors have a separate entry directly leading to the basement for dedicated staff parking areas. The elevators lead them up to their designated areas, minimising visitor contact with the staff.

4. The Layouts

The Emergency Block in the south has a separate entry and includes triage, protected wards and sterile support for rapid care. The OPD Block in the northeast captures morning light to reduce congestion and enhance patient comfort, housing consultation rooms, pharmacy and administration. The centrally placed Diagnostics Department connects Emergency Block and OPD with dedicated entries, adjacent to the Blood Bank for quick access. A large central Waiting Area aids orientation and flow.

Central atrium – a healing journey: A bright, green atrium serves as a calming gateway, guiding patients through a natural, therapeutic space that eases anxiety and softens the clinical environment. Well-lit courtyards, wide corridors and vertical circulation ensure smooth movement throughout (refer Figure 4).

Figure 4: Ground floor plan

First level: The first floor features the OT complex above the Emergency Block and expanded OPD with adjoining Day Care, separated by corridors. It includes a student classroom, 'biophilic' terraces for the classroom, Day Care, OPD and separate lifts for sterile patients, regular patients and visitors.

Second level: The second floor houses the labor and birthing unit above the OT complex, an extended OPD area above the first-floor OPD and a central administration zone.

Third level: The entire third floor houses the ICU complex and a large rooftop healing garden with therapeutic plants like Ocimum Tenuiflorum (Tulsi), promoting stress relief and recovery. This garden breaks from typical hospital design by integrating

nature into healing. At the garden's front is a Narmada-inspired curved landscape, visible from the rooftop (refer Figure 5 and 6).

Figure 5: Healing terrace with medicinal flora and patient-friendly circulation

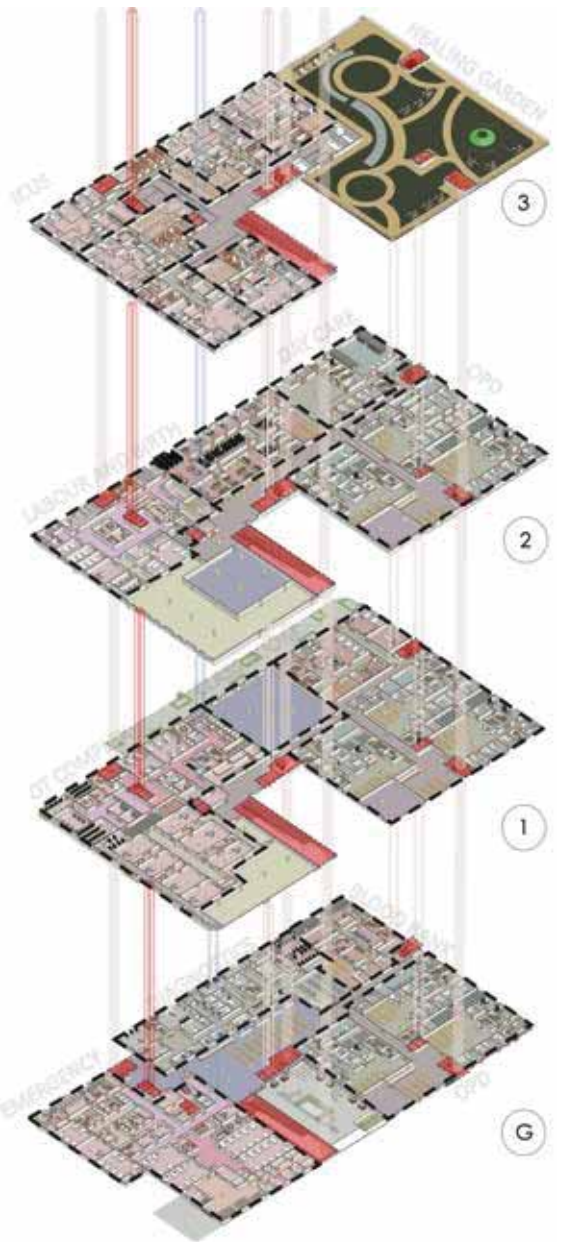

Figure 6: Axonometric view of ground,1st, 2nd and 3rd Floor

Fourth to seventh level: Each in-patient bed is carefully positioned to offer clear views of the outdoors, helping patients connect with nature, reduce stress and promote faster healing. This design breaks the typical hospital barrier by softening the clinical environment with natural scenery. Additionally, large stepped healing terraces on each floor provide safe, accessible outdoor spaces where patients can experience fresh air and greenery, further enhancing mental and physical recovery while maintaining sterility.

Eighth level: This floor includes a pediatric in-patient department with a dedicated rooftop healing garden designed to support children's recovery by providing a comforting and engaging outdoor space. This helps reduce their fear of the hospital, allowing them to feel more relaxed and free (refer Figure 7).

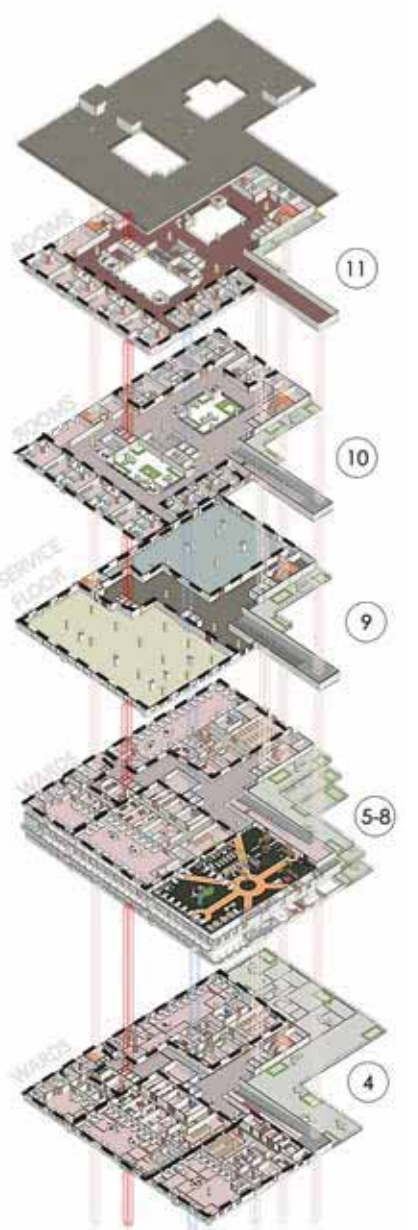

Figure 7: Axonometric view of 4th – 11th Floor

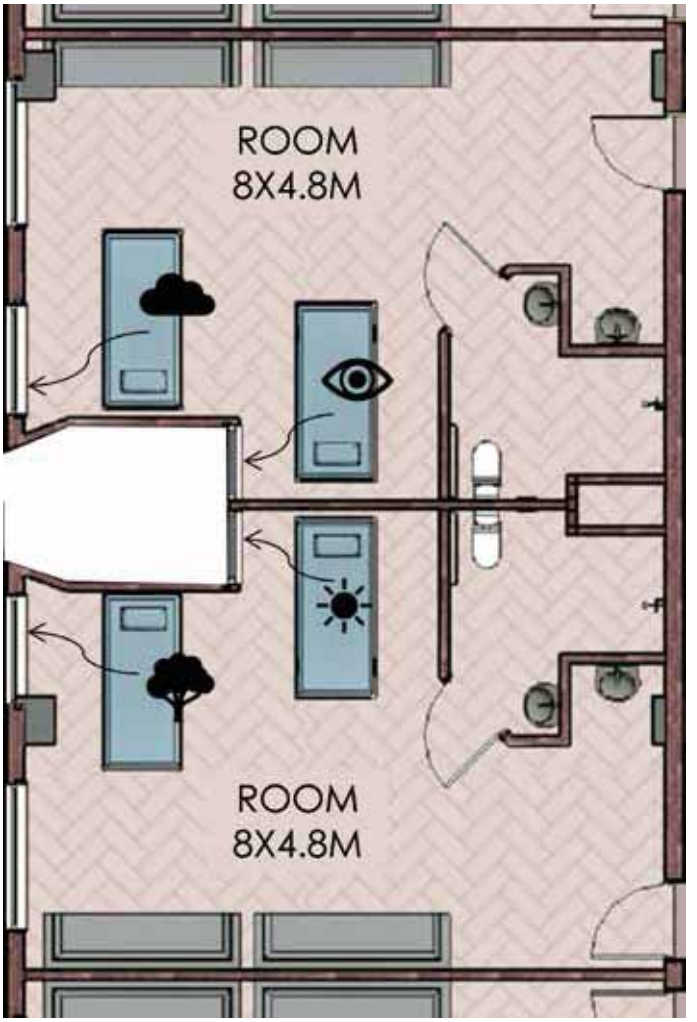

Figure 8: Rooms on 10th and 11th Floor Plan - splayed walls ensure both patients enjoy open views and natural light

Figure 9: Each patient enjoys an individual window, ensuring privacy, daylight and connection to nature

Ninth level: This floor houses service areas required to support the hospital.

Tenth and eleventh level: These floors feature private patient rooms complemented by internal healing courtyards and terraces. Each room offers dedicated windows with unobstructed views of a serene Narmada-inspired landscaped area, designed to promote relaxation and accelerate healing. The

Figure 10: Sectional view showcasing healing step terraces that invite light and nature into the building

natural light and visual connection to greenery through these windows help reduce stress, improve mood and enhance mental well-being (refer Figure 8 and 9). In two-seater rooms, the outer walls are splayed and beds carefully positioned so that each patient has their own window and direct access to calming outdoor views, supporting faster recovery and greater comfort.

5. Conclusion

Hospital design prioritises patient-centered care by integrating nature, light and thoughtful spatial planning to promote healing and well-being. Through biophilic elements like healing gardens, terraces, (refer Figure 10) and views inspired by the Narmada landscape, the design breaks traditional hospital barriers, creating a calming and restorative environment. With strategic layouts ensuring privacy, efficient circulation and dedicated facilities for all patient needs, this design fosters faster recovery, mental peace and a holistic healthcare experience for patients, visitors and staff alike.

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Chandigarh Experiment with Sustainability and Sustainable Development

By Ar Jit Kumar Gupta

Introduction

Ever since, report of the UN Commission on Environment and Development (Brundtland Commission) used the term sustainability and sustainable development, as the panacea to optimise , minimise and rationalise the production and consumption of resources, context and focus of global intent, content and approach to growth and development and planning, development and governance of human settlements, has undergone a paradigm change. The Commission on Environment and Development Report of 1987, 'Our Common Future', also defined sustainable development as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs". Once the report was accepted, it helped in integrating and embedding sustainability into the mainstream of policy formulation and project implementation across nations. The report also popularised the concept of sustainable development for ensuring that human beings on this earth should not live focusing only in the present but also look at their next and future generations to come, for ensuring that they also have a right and free access to adequate opportunities, options and resources for having quality living. In search for possible options, the UN report mandated that all nations should include, involve, embed and peruse sustainable development, as the mechanism, for achieving the long-term goal of sustainability, through all the policies framed, programmes launched and development undertaken in its physical boundaries at local, regional and national levels. The UN Report, over the years, has changed the entire context of development in general and urban development in particular, both of them undergoing a dimensional change.

Looking at the global scenario, it has been concluded that majority of prevailing global ills and challenges in terms of climate change, rising temperature, global warming , ozone depletion and increasing carbon footprints, that are facing humanity and communities, have roots/genesis, which can squarely be attributed to the manner in which countries, regions and states are urbanising, the pattern in which population is increasing, getting distributed and concentrated in urban settlements, the pace at which people are migrating to cities and the manner in which cities are growing in physical, economic and social dimensions. Irrational, haphazard and unplanned growth, lack of basic amenities and services are making cities less pleasant, less productive and inefficient, resulting in unsustainable spaces for human living. Irrational, outdated and out of context planning options used for making the growth and development of urban areas rational and realistic, have also contributed to making cities unsustainable, consumers of large resources and generators of large waste. Ever increasing congestion caused by undue concentration of people, issues related to travel and traffic and uncontrolled urban sprawl, coupled with inadequacy of essential services and concentration of poor and poverty, have made cities major agents of propelling unsustainable development. Considering the fact that urban development has major implications in achieving sustainability, accordingly, principles of sustainable development of cities and towns have emerged, critical and valuable for achieving the goal of health, happiness and quality living on the planet earth.

While the UN report called for embedding sustainable development as an agenda for rational urban development in the year 1987, Chandigarh capital city, embedded the idea and concept of sustainability way back in the year 1950, during the last century. Despite coming out of the shadow of great human disaster and faced with numerous physical, social, economic, political challenge, resource and technological limitations, Capital City Chandigarh, more than 40 years before the UN Report, embraced and embedded the concept of sustainable development, in its siting and planning, development and management of the new capital city for the state of Punjab. The credit for embedding the concept and approach of sustainability in the planning, design and construction of Chandigarh goes to the Politicians, Administrators, and teams of International and Indian Architects, Planners and Engineers, involving first team of Architects and Planners, led by Albert Mayer & Mathew Nowicki and the second team of professionals led by the Master Architect Le- Corbusier & Perrie Jeanerette, Maxwell Fry, Jane B Drew, who were ably and amply supported and empowered by Indian Architects and Planners.

Despite the fact that Chandigarh, has been globally considered and acknowledged as a role model and great experiment in defining new urbanism, promoting planned development, creating new cities, creating state of art architecture, ensuring quality development, rationalising traffic and transportation and embedding innovations in urban governance, the city of Chandigarh has never been evaluated in terms of contribution and value addition made in the domain of urban sustainability at local and global levels. The valuable contributions made by the city in the domain of sustainable urban development still remains muted, diluted, marginalised, unacknowledged and ignored even after more than 75 years have gone by, when the city was conceptualised. This is despite the fact that Chandigarh was developed without having any law providing for preparation and implementation of a Master Plan for the city.

This brief write-up, is an attempt to enlist and showcase few of the innovations made in the siting, planning, designing and construction of city and buildings in Chandigarh, which when recognised, can help Chandigarh capital city to be rated, recognised and credited to be the pioneer, and perhaps the first new global city, to be placed on the pedestal of sustainable Urban Development. The sustainability of the city is explained and evaluated in terms of its siting, planning, architecture, materials, technologies etc., used in the making of the capital city of Chandigarh.

- **Achieving Sustainability through Appropriate Selection of Site for the City:** In the parlance of any urban development project, siting of the project plays critical role in making it sustainable, particularly in the case of siting of a large project, like capital city. Among numerous new cities planned globally, Chandigarh holds the distinction of having one of the most appropriate and sustainable sites. The credit for selecting one of the most sustainable sites goes to the Indian team led by Er P L Verma, first Chief engineer of the project.

  Located in the centre of the then state of Punjab, in close proximity to the national capital of Delhi, having the distinct advantage of existing rail and road connectivity and freedom from majority of physical encumbrances, made site unique and a major element in the success and sustainability of Chandigarh as a city. The site for the Chandigarh capital city remains different and distinct, for the reasons mentioned - it is precisely defined by distinct and unique natural features, on three cardinal directions of North, East and West. Located in the lap and shadow of Shivalik range of hills in the northern side, the site is bounded by two seasonal choes (rivers) namely; Sukhna Choe on eastern side and Patiali-ki-Rao Choe on the western side. Only the southern side remains available for expansion of the city.

  Enclosure by three distinct features has helped in saving site from unauthorised and unplanned development besides containing the development in a finite physical context. Having a gentle slope from north to south, has enabled the site in making value addition to the city by making its development economical and cost-effective, by ensuring supply of water and drainage of storm and sullage water, based on the law of gravity. Existence of a Choe in the center of site, was used for making city sustainable by converting, planning and developing it into a green belt, besides using it for draining off the storm water of the adjoining sectors. The selection of appropriate site has helped Chandigarh in making city planning and development most sustainable, cost-effective and eco-friendly **(Image1).**

- **Achieving Sustainability Through Planning of Chandigarh on Human scale and Planning with Nature:** The second factor which makes

Image 1: Site & Overall Plan of the new Capital Chandigarh
Source: www.archdaily.com

Chandigarh a sustainable city, is the fact that Chandigarh as a city has been planned with its genesis on human scale. The edict of Chandigarh defines the basic intent and philosophy of the planning of Capital city of Chandigarh in terms of:

- "The city of Chandigarh is planned to the human scale. It puts people and city in touch with the infinite cosmos and nature. The city also provides us with places and buildings for all human activities in which the citizens can live a full and harmonious life. Here the radiance of nature and heart are within our reach."

  Further, "The city is composed of sectors. Each sector is (½ mile x ¾ mile) 800 meters x 1200 meters enclosed by roads allocated to fast mechanised transport and sealed to direct access from the houses. Each sector caters for the daily needs of its inhabitants, which vary from 5000 to 25000, and has a green strip oriented longitudinally stretching centrally along the sector in the direction of the mountains. The green strip should stay un-interrupted and accommodate schools, sports, walks and recreational facilities for the sector. Vehicular traffic is completely forbidden in the green strip, where tranquility shall reign and the curse of noises shall not penetrate."

Looking at the entire context of planning for making city sustainable and people friendly, a sector has been taken as the basic unit of planning. The dimensions of the sector, 800 meters x 1200 meters was fixed rationally and logically, keeping in view the ease of human mobility, to promote walkability with all basic amenities made available within a walking time of 10 minutes only. It remains the first city which has been planned on a human and time scale, making Chandigarh a 10 minutes city.

Sector planning: analogy of a city within city, self-contained and self-sufficient in all basic needs of daily human living including shelter, education, healthcare, leisure, shopping etc. In order to connect the city with nature and with Shivalik range of hills on the north, a central green flowing north-south, has been provided to form integral part of the sector planning and connecting it with adjoining sectors. For ensuring safety from vehicular traffic, all fast- moving traffic has been kept on the periphery of the sector, whereas only slow-moving traffic meant to cater to the needs of the residents and approaching individual houses, has been included within sector planning. For restricting induction in number of vehicles, only four entries, one from each side of the sector, have been provided for the vehicular entry and exit. In order to enable residents having a peaceful living, sector planning is in introvert manner with no house opening /facing the main road of V2 & V3. These basic planning principles have been embedded in the planning of all the residential sectors falling in the stage 1&2 of Chandigarh. **(Image 2)**

Image 2: Plan of Residential Sector 15, Chandigarh
Source: in.pinterest.com

- **Achieving Sustainability by Creating Manmade Water body- Sukhna Lake:** Chandigarh suffered from the radiation of extreme heat during summer months. It lay in composite climatic zone and it also did not have any perennial source of water. For modulating the micro-climate in the city, manmade Sukhna lake was created by the planners of the city, by putting a barrage across the Sukhna Choe, coming down from the Shivalik Hills. Occupying an area of 3 km^2 a rain fed lake was created in 1958. The

water-spread area of the lake has been placed at 188 ha with average depth placed at 18 feet. In 1988, the Ministry of Environment and Forest, Government of India, recognised 228.66 ha of Sukhna Lake as one of the National Wetlands. Edict of Chandigarh, authored by Le-Corbusier has mentioned Sukhna lake in terms of,

- "The lake is a gift of the creators of Chandigarh to the citizens to be at one with nature, away from the hubbub of city life. There shall be no commercial exploitation of the lake and its environment and its tranquility shall be guaranteed by banning noises."

With careful and innovative landscaping, having a people friendly walk way and sitting spaces, Sukhna lake has emerged one of the most visited and preferred public spaces for promoting walkability & water sports, providing leisure and attracting large number of visitors both from within and outside the city, particularly in summer, both morning and evening. Supplemented by the Lake Club, having cafeteria, lawns, gym, indoor games, swimming pools and large tennis courts, water sports like boating, rowing, sculling, sailing, kayaking and water-skiing can be enjoyed throughout the year. The lake was also the venue for hosting the Asian Rowing Championships, being the longest channel for rowing and yachting events in Asia **(Image 3).** Beside emerging as the major sports, tourism and leisure hub, Sukhna lake has contributed much to the sustainability of the Chandigarh city by:

Image 3: Manmade Sukhna Lake, Chandigarh
Source: dreamtrails.in

- Providing large space for sourcing, collecting water and rainwater harvesting
- Providing largest manmade water reservoir in the city
- Improving micro- climate of the city
- Lowering ambient temperature in the nearby residential sectors,
- Promoting recharging the ground water on continued basis
- Raising the ground water level
- Supporting afforestation on large scale in the surrounding area and
- Attracting a large variety of native and exotic migratory birds in the area
- Promoting water sports on large scale
- **Achieving Sustainability through Planning and Developing A Valley of Leisure:** Planned to promote sustainable urban development, the city focused on improving the quality, health and life of the residents by taking care of the needs of their body and spirits in addition to catering to the quality living and working. Accordingly, to make Chandigarh a happy, healthy and sustainable place to live, Le Corbusier retained the eroded valley of a seasonal rivulet on the original site of the city and sculptured it into a Linear Park. Having a total length of 8km, the leisure valley covers from Sector 1 in the north and leaves Chandigarh at its southern most edge in sector 53. Known as the city of gardens, leisure valley houses in all 12 parks and gardens including the most famous gardens of the city namely, Rajendra Park, Rose Garden, Terrace Garden, Shanti Kunj and other theme gardens besides providing space for housing sports stadiums, museums etc. Housing large landscaped area, known as the green lung of the city, this leisure valley provides the largest and longest green space at the city level. It has helped in not only promoting aesthetics and improving urban design, it has also moderated and modulated the harsh climate prevalent in the city. Leisure valley also remains host to a number of festivals including three-day carnival, Rose Festival, held annually in the month of February to celebrate the blooming of the roses in the valley**. (Image 4a, 4b)**
- **Achieving Sustainability through Protecting Existing Wealth of Trees:** Chandigarh has been globally valued for its large inventory of trees existing in the city. Much of this credit goes to the innovative order, 'Chandigarh Tree Preservation Order', published vide Notification No. C-4200-52-4/3540 dated 23rd June, 1952 and made operational immediately in 1952. The order was issued under the power and authority vested by the section 11 of the Capital of Punjab (Development and Regulation) Act, 1952. This unique order provided that:

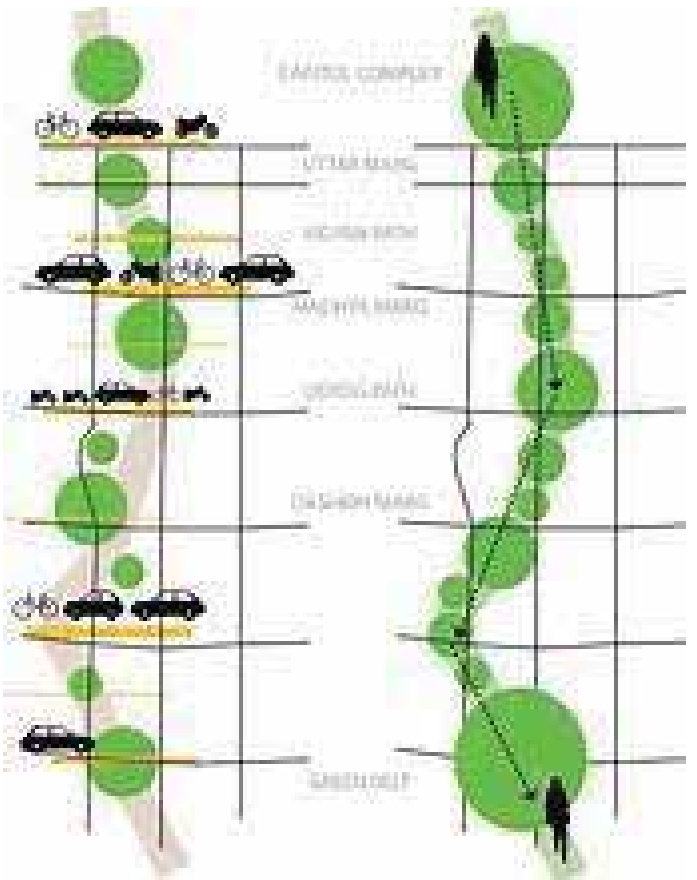

Image 4a, 4b: Rose Garden, Leisure Valley, Chandigarh
Source: Chandigarh.gov.in

- all existing trees, falling within the area acquired for the new city, were deemed to be protected trees and no hopping, lopping, chopping and topping of existing trees was permitted, without obtaining prior permission of the Chief Administrator.

In case of removal of any tree/ trees, an application has to be made to the Chief Administrator, which could be refused based on consideration of:

Trees having value in the interest of good forestry; or having an amenity value in relation to the woodland character of the area, or having an outstanding amenity value for offering shade to the building or roads, or for any other special amenity provided by the trees or woodland area.

Where permission was granted, the owner of any site was required to plant or replant trees or kinds of trees, as may be directed in the order. The trees to be protected were made an integral part of urban planning process by including them and showing them on the zoning plans as "protected trees" or in "protected woodland areas". This order was also valued in the planning and development of the cities both by the planners and the people, which helped in preserving the existing trees in the city. Chandigarh as a city remains the pioneer, role model and most sustainable city in the country to have such an order, valuing and protecting existing trees**. (Image 5)**

Image 5: Protecting Trees under Tree Preservation Order, 1952
Source: Chaman, 2017

- **Achieving Sustainability through Creating a Periphery for the City:** For making Chandigarh a unique city, embedded with sustainability, it was thought prudent by administrators, planners and architects connected with the city, that planned nature and character of the new city must be conserved and preserved, by eliminating any possibility of unplanned growth and uncontrolled urbanisation taking place in the peri-urban area. In addition, the city was also to be expanded in area and population, for accommodating balance population of 3.5 lakh proposed to be added in the second stage of city development, for which requisite area, free from all physical encumbrances, was required to be made available at a subsequent date. Further, it was also felt that Chandigarh must be

planned and developed in the regional context by defining a distinct region, in the shape of a periphery around the city. The Periphery was envisioned to be protector of the city against any unforeseen forces generated by unplanned and haphazard development and unregulated urbanisation. In addition, the Periphery was also required to support the city, by making available all basic goods, essential for day-to-day human living including food, milk, fruits, eggs, vegetables etc., in the immediate vicinity of the city, without the need for transporting them from long distances on daily basis. In order to meet these planning and developmental challenges and opportunities, The Punjab New Capital (Periphery) Control Act, was enacted in the year 1952. The aim and objectives of enacting the said Act was stated to provide:

- for making available additional area for future extension of the Capital city
- ensuring healthy and planned development of the new city
- preventing growth of slums and ramshackle construction on the land lying on the periphery, it is necessary to have legal authority to regulate the use of the said land for purposes other than the purposes for which it is used at present.

Considering the needs of the development of the capital city, initially an area, falling within 8 kms, on all sides from the outer boundary of the land acquired for the Capital of the State at Chandigarh as that Capital, was declared to be Controlled Area. The limit of the controlled area declared under periphery, was later extended from 8 kms to 16kms, in the year 1962, considering the developmental pressure caused by shifting of the Western Command Headquarter from Shimla to Chandi mandir and setting up of large industrial unit of HMT near Pinjore /Kalka.

Further for regulating the growth, development and defining the use permitted for the land falling in the Controlled Area declared under The Punjab New Capital (Periphery) Control Act,1952, the Deputy Commissioner of Chandigarh was mandated to prepare a plan of the said “Controlled Area”, signifying therein the nature of the restrictions to be made applicable to the said area.

The Act was able to achieve its defined objectives to a large extent, till the year 1966, but lost its relevance when state of Punjab was bifurcated, with the creation of State of Haryana and Chandigarh becoming an independent administrative entity (Union Territory), on November 1, 1966. With this, the Periphery was also sub-divided into 2 states and Chandigarh UT. 75% area of periphery went to the state of Punjab, 21.7% to the state of Haryana and Chandigarh UT left with only 3.3% of total controlled area of 1430 Sq kms**.** After 1966, Periphery Controlled Act lost its role and relevance leading the periphery to emerge as the most potential area of intensive urbanisation in the region. Despite these later distortions, propelled by the change in geo-political changes in the state of Punjab, The Punjab New Capital (Periphery) Control Act, remains the most potent and valued instrument to promote sustainability of the city and integrating it with the region. **(Image 6)**

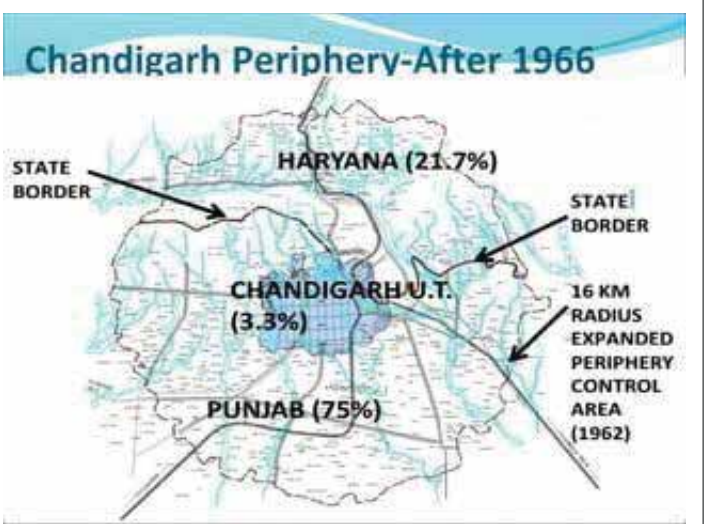

Image 6: Periphery Controlled Area, Chandigarh
Source: www.slideshare.net

- **Achieving Sustainability through Making Landscaping Integral part of City Planning:** If Chandigarh is known to achieve sustainability through planned development, the contribution made by landscaping in its journey to sustainable development, cannot be ignored and marginalised. Along with the urban planning, Chandigarh holds the unique distinction of also being credited with having a master plan for the landscaping of the city, as part of the planning of the city itself. Blessed with Sun, Space & Verdure, as basic forces shaping town planning and architecture, Chandigarh remains one of the most professionally planned, designed and planted city of India. Following the basic planning principles of living, working, jobs and circulation, Chandigarh landscaping

has been guided by marrying buildings with trees and linking man with nature for creating and achieving harmony besides enhancing architectural quality of buildings for providing individuality to each element of the city design.

Conceptualised and detailed by Dr M S Randhawa, landscaping of the city has been based on careful observation of the selected trees / vegetation based on, textures, colour, foliage, shape of crown, architectural appeal and contrast available in India. Selected ornamental trees, shrubs and climbers, available within and outside the region, have been planted in the city, in accordance with a pre-defined colour scheme to beautify the space and the area. Innovative landscaping planning has given the capital city of Chandigarh, a distinct and different character. The Edict of Chandigarh has also mandated that in future, the planting and replacement of trees, the basic principles enunciated above for landscaping must be kept in view and there should be no haphazard replacement, so that the existing avenues retain their harmony and beauty. The city also follows a well-defined hierarchy of open spaces in its planning and development, which has placed it on a pedestal and ranked as one of the most sustainable cities in the country **(Image 7).**

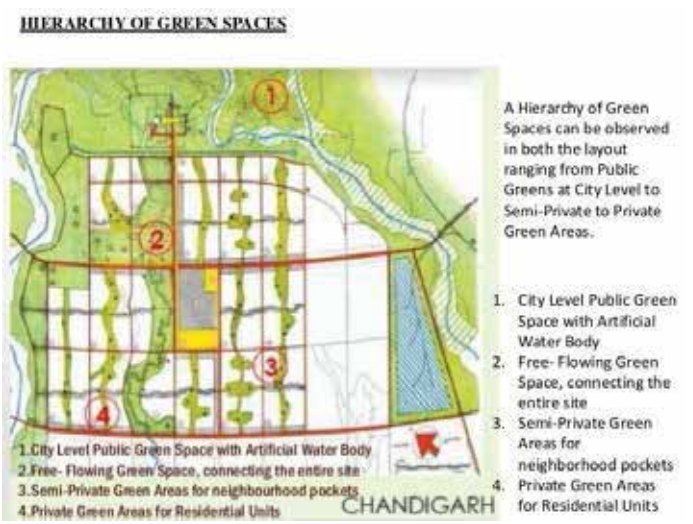

Image 7: Landscaping and Hierarchy of Open Spaces in Chandigarh
Source: www-rethinkingthefuture.com

- **Achieving Urban Sustainability through Well-Defined pattern of Mobility and Transportation:** Traffic, transportation and mobility are known to have a great role to play in making any city and urban settlement sustainable. In the planning hierarchy evolved for the city, Corbusier placed and ranked travel with lowest priority in the city planning with order of priority going to living, working and jobs. Placing lowest, Corbu also mentioned that urban planning must lead people to travel minimum. That is the reason why sector in Chandigarh has been conceived to be a city within city. Sector has also been planned to be a 10 minutes city, based on human scale of walking. In addition to travel within the sector, Corbu also provided a distinct hierarchy of roads for the city, mapping traffic coming from outside the city to the traffic going to individual houses. Defining the system of 7Vs, the entire traffic was divided into two distinct categories, fast and slow traffic. Considering the safety of people and ease of mobility, all fast moving traffic was placed outside the sector (V1- V3), while all slow-moving traffic (V4-V7), was allowed to operate within the sector.

  For catering to the traffic, comprising of large number of people using bicycles for travel and accessing places of living, working and leisure, Corbusier amended the Rule of V7 to include V8bc. In order to meet the subsequent need of moving large number of people in the city, Corbusier also planned a bus-based mass transportation system for Chandigarh. Mass transportation system envisioned using three different categories of the buses having variable carrying capacity, with large capacity buses to run on the major axis, buses with medium passenger capacity to run on sector dividing roads and mini buses planned to run within the sector on V4. With a single ticket and having maximum two change of buses, one could reach any destination within the city. Chandigarh was the first city to have a well-defined pattern of urban roads, with due importance given to mass transportation, bicycles and pedestrians. In addition, to overcome the challenges of cost and catering to the likely congestion created at the traffic junctions, Corbu also provided a cost-effective system of designing road junctions, based on four distinct phases of development, in order to make entire development sustainable, rational and cost-effective. All major roads (V1&V2) are called Marg whereas all other (V3s) are called paths. No road is named after any person. Roads in the city have been named based on the cardinal direction they follow and the destinations to which they lead to**.** Rule of 7 Vs, envisioned for the city, remains one of the finest, simple and sustainable system of travel for a city planned on the analogy of grid-iron pattern **(Image 8).**

- **Achieving Sustainability through Planning a Compact City:** Despite the fact making cities

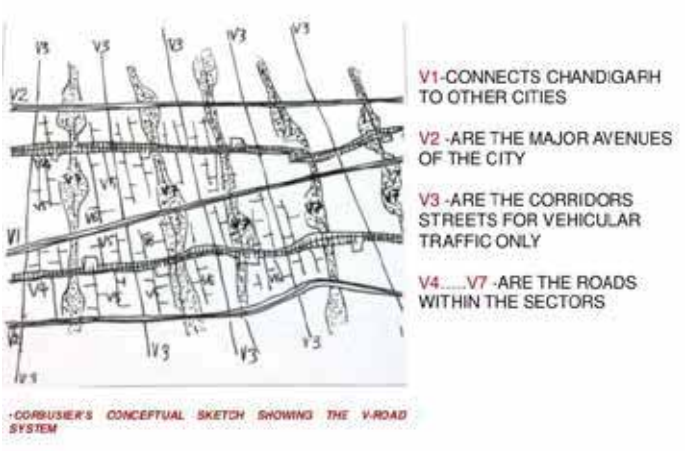

Image 8: Hierarchy of Urban Roads – Rule of 7Vs in Chandigarh
Source: www.slideshare.net

compact has been promoted recently as a concept for making cities walkable, sustainable and livable, the idea of compact cities had the genesis and origin in the planning and designing of the capital city of Chandigarh. Chandigarh remains perhaps the first city globally holding the distinction of being conceptualised and planned as a finite and compact city, that too as early as 1950.

Conceptualised as a city having an ultimate population of 5 lakhs, Chandigarh was envisioned to achieve the designed population in two distinct stages of planning and development. Stage 1, was planned to be low density housing 1,50,000 people in an area of 9,000 Acres. Stage 2 was planned for high density, accommodating a population of 3,50,000 in an area of 6,000 acres. When given the idea of having satellite towns or expansion of the city for accommodating additional population when the city exceeds the designed population of 5 lakh, Corbu rejected all the ideas and said additional population, beyond 5 lakhs, will be accommodated within the city, without increasing the area and defined boundaries of the city. Corbusier also negated the idea of setting up of a satellite town in the vicinity of new city to accommodate the surplus population of the city. Additional population was proposed to be accommodated in stage 3 of the development of the city, which was to be taken up as re-densifications of Stage 1, which had low density (16.7 ppa) due to lesser population accommodated in large area as compared to density of Stage 2 (58.3 ppa) of city development. Thus, Chandigarh embedded the idea of re-densification of the city for remaining finite, compact and sustainable. However, the idea could not be made operational due to Government of Punjab remaining non-responsive even when Corbu wrote that city needs to take up the study and evolve solutions to make re-densification of Chandigarh a distinct reality **(Image 9).**

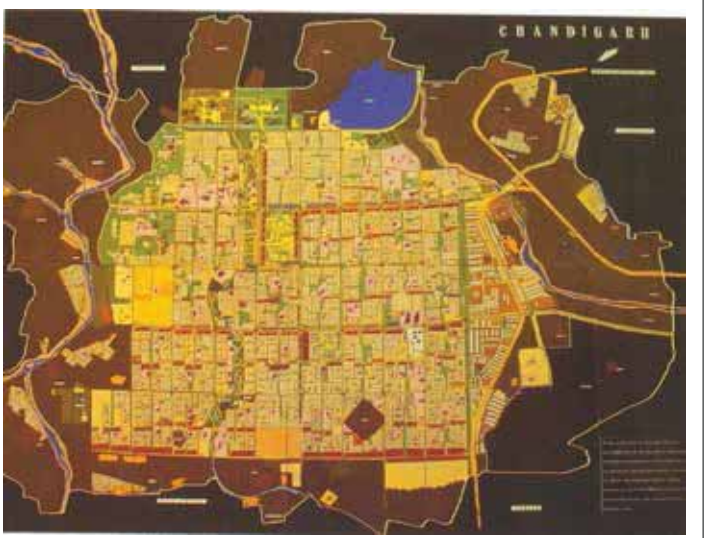

Image 9: Planning Chandigarh as a Compact and finite City
Source: www.pinterest.com

- **Achieving Sustainability Through Experimenting with Rain Water Harvesting:** Rain water harvesting has recently been recognised as one of the mechanisms of promoting sustainability in terms of water, by optimising the use of rain water. Chandigarh was perhaps the first capital city of India, which demonstrated the role and relevance of harvesting rain water as an integral part of the building design for making value addition to the art and science of designing buildings and promoting sustainable architecture. Rain water harvesting as an integral part of building design in Chandigarh was taken up while planning and designing the High Court and Assembly buildings in the capital complex.

  Rain water harvesting was embedded by creating two large tanks for collecting rain water as a part of the design for retaining the rain water collected and discharged from the building roof. Rain water tanks not only modulated the harsh climate in the complex, but also provided a cost-effective solution for rain water disposal from the building besides adding to the aesthetic and sustainability of the buildings designed by reflecting images of the buildings **(Image 10).**

- **Achieving Sustainability by Using Local Materials and Pre-fabrication:** Burdened with availability of limited financial resources,

Image 10: Chandigarh Experiment with Rain water Harvesting in Assembly Building
Source: Ravenscroft, 2023

limitations imposed by estimated cost, period prescribed for construction, number of houses to be constructed, non-availability of variety of buildings materials, non-availability of steel and cement, prevailing high cost of timber and glass, absence of latest construction machinery and advanced technologies, led the project team to think and innovate methods of planning, designing and construction of buildings to make them cost-effective, time-efficient, with quality and sustainability. In search for appropriate options to make buildings sustainable, Chandigarh was perhaps the first city to give the idea of using cost-effective materials which were available locally like bricks and stone, in the natural form, without plastering and painting. Chandigarh also ranks as a pioneer among new cities in India to showcase the inherent strength and distinct advantage of using concrete in natural form, as a wonderful building material in all buildings of public importance. In search for solution to construct buildings in the minimum time span and with limited cost, Chandigarh introduced the concept of pre-fabrication or off-site construction for majority of building components and taking forward the concept of mass production in the construction of houses. Sharing of walls and sharing of services was leveraged as a concept to promote economy in the cost of buildings. In order to make buildings cost-effective and sustainable over the entire life-cycle, the concept of life-cycle cost, in addition to initial cost, was embedded as part of design and construction of buildings **(Image 11).**

- **Achieving Sustainability by Valuing Principle of Circular Economy:** Despite all odds and limitations, Chandigarh is credited with being the first city which worked on and practiced the

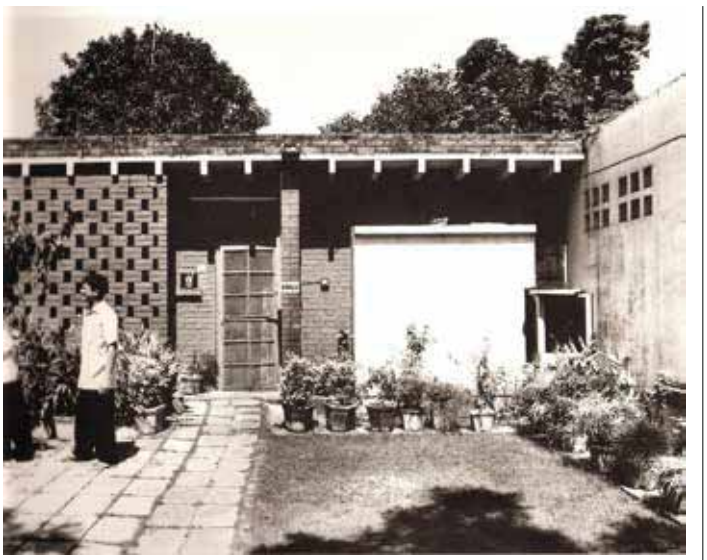

Image 11: Sustainability by using Local Material, Prefabrication, Chandigarh
Source: Author

concept and practice of circular economy in the domain of urban planning and development, and also made it a distinct reality and great experiment in modern urbanism. With large amount and variety of waste generated in any new city, the said waste was innovatively used to create the **Rock Garden,** which has over a period of time emerged as one of the most favoured tourist destinations. Spread over an area of 40 acres (16 ha), Rock Garden is completely built from industrial and home waste with discarded items. It includes a large network of waterfalls, rocks, hills, gardens, flora & fauna, swings, aquarium, sculptures, theatres and villages, all made out of scrap and waste material like glass bottles, bangles, tiles, ceramic pots, sinks, and wires. Rock garden has demonstrated how human ingenuity can be used in leveraging the strength of waste to convert it into wealth for the city. It has been recognised as a public space having aesthetic, cultural and artistic value. It has been globally acclaimed for its pioneering role in environmental art and recycling movement, demonstrating how art can transform urban spaces & engage communities by creating an urban space offering both aesthetic pleasures while promoting sustainability & resource reuse. Valued as a most vibrant & interactive place, both for locals and visitors, the Rock Garden offers something for visitors of all ages and accordingly, has been repeated and duplicated at numerous places**.**

- **Redefining Architecture in Indian Context:** Chandigarh Architecture is globally recognised for its sustainability, uniqueness and freshness,

for giving a new meaning, status and definition to the art and science of designing sustainable and quality buildings. Despite constraints, Corbusier promised a unique life, unique city and unique buildings to the inhabitants of the new city. Known for quality, innovative design solutions and cost-effectiveness, Chandigarh architecture became a role model of valuing relevance and importance of materials, promoting truthfulness of materials involving concrete, bricks and stone and using manpower not machinery, for achieving economy. Accordingly, Chandigarh Architecture became a product of climate, cost and quality of built environment. Protection from sun and dust laden winds of hot seasons, discipline of cost, material, technology and climate, led to creating a box-like structures of bricks/ stone, with small windows protected by brise-soleil, which led to a beginning of a new style, which Architects had not consciously sought before and now became the hallmark of Chandigarh architecture **(Image 12).**

Image 12: Chandigarh Architecture- product of climate, cost and quality
Source: Author

Conclusion: Looking at the few examples given above, it can be seen that, despite all limitations and challenges imposed by climate, physical, social, political and economic factors, Architects, Planners and Engineers involved and engaged in making Chandigarh a distinct reality, did use their knowledge, skill, expertise and understanding to embed the element of sustainability in all aspects related to planning, designing and construction of the city. This fact needs research and recognition, because it all started in the year 1950, when Chandigarh started creating its footprints on the site identified for the capital city. It remains important for the reason that the concept of urban sustainability was non-existent in the dictionary of planning of cities at that time.

This paper, dedicated to decipher the role played by Chandigarh in making city sustainable, is primarily the outcome of my limited knowledge and understanding of the making of the great city. I think city has made valuable contribution in the domain of urban sustainability, which remains unknown, un-researched and un-documented. In order to do justice to the city and professionals contributing to making the city sustainable, it will be important to map and document various aspects of sustainable development. For realistically and rationally mapping the contributions made by the capital city of Chandigarh in the realm of urban sustainability, it will be desirable that a detailed study on the subject needs to be taken up by the Chandigarh administration, researchers, scholars and experts having commitment in the domain of sustainable urban development. Such a study will help in showcasing locally and globally, the path of planning and designing sustainable cities.

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ARTICLE

Weaving 'Delight' into Circulation Spaces in Built Forms

Some Tried and Tested Techniques

By Ar Pramod Beri

INTRODUCTION: NEED OF A CELEBRATIVE AND DELIGHTFUL TRAVERSE IN CIRCULATION SPACES

Most of the building plans for medium and large sized institutional projects broadly consist of various function related blocks such as the arrival block, the administrative block and blocks for different required functions. Human traverse in such buildings is from block to block as well as inter block movement.

An effort has been made in this essay to enumerate such techniques that add an emotive value to such human traverses. This improves the otherwise mundane spatial quality in such traverses and goes beyond the functional parameters into the zone of celebrative delight.

In most of the institutional buildings these circulation passages are just of minimal width and are monotonously rectilinear. Hence, the traverse from point A to point B in such spaces lacks feeling of delight and surprise.

In this essay, let us explore some laterally thought-out techniques which I have used to add this celebrative experiential quality. The purpose is to kindle the spark in emerging and young professionals to consider these techniques to enhance the quality of delight in such areas.

Present scenario – Need for a change

Corridors and passages in most of such built-forms are straight, long and with minimal width rectilinear format. This creates a mundane feel. Such spaces are also devoid of natural daylight and ventilation (See Fig 1).

Fig 1: Straight, long and with minimal width rectilinear format corridors are typical

FIRST SITUATION AND RELATED 'DELIGHT' INDUCING TECHNIQUES – The situation consists of two building blocks connected by a long corridor, with either side offering delightful green spaces.

However, this aspect can be further be glorified by creating a pause space in such corridor at the midlevel. Further, in such corridors the first-floor connection between blocks can be made interesting

by enclosing the expanded portion by a Jali and even adding a "Jharoka" to it. The expanded portions serve as stand aside discussion spaces while the regular traverse continues (See Fig 2, 3, 4).

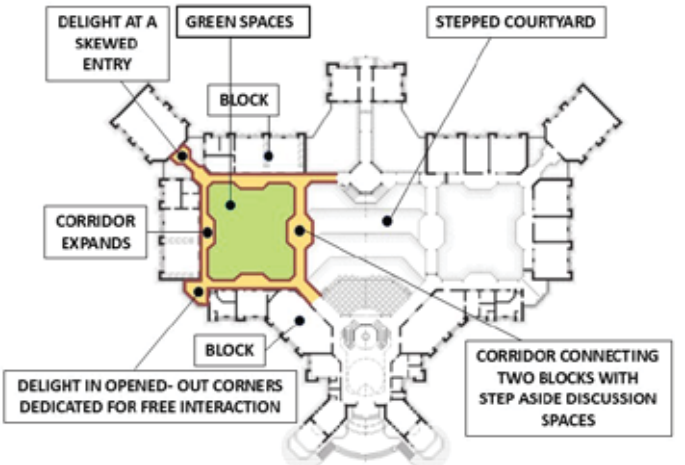

Fig 2: Warana Military Academy, Warananagar - Plan

Fig 3: Warana Military Academy, Warananagar – Courtyard view

Fig 4: Warana Military Academy, Warananagar – Jali with Jharokha detail

(Ia) Another variation to the first situation

The spatial quality in the passage could be further enhanced by adding diagonal beams in the RCC slab covering it (See Fig 5).

Fig 5: Mother and Child Centre, Miraj – Diagonal beams

SECOND SITUATION AND RELATED DELIGHT INDUCING TECHNIQUES

Traverse passage around landscaped courtyards, which accesses various rooms on three / four sides.

In most buildings, traverse along such square / rectangular circulations passage around a courtyard ends in a point to point that is room A to room B travel with only delight afforded from the adjoining green space.

However, such passages also can be glorified by expanding the passage at mid portions as well as at corners and adding seats for interaction at expanded junctions (See Fig 6, 7) as done at Bharati Nursing College, Sangli.

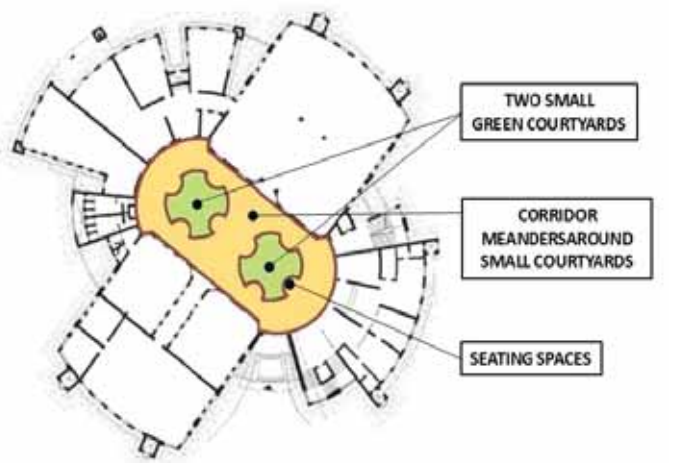

Fig 6: Bharati Nursing College, Sangli – Landscaped courtyard plan

(IIa) A Variation to the second technique

If at the junction of blocks, a dedicated interactive space is kept, it would result in more delight with a bonus of glimpse of the outside view (See Fig 8,9).

Fig 7: Bharati Nursing College, Sangli – View of landscaped courtyard

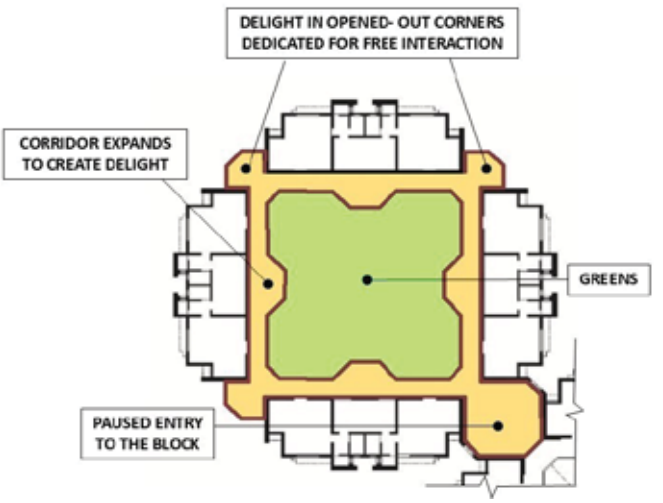

Fig 8: Hostel – Warananagar – Opened out corner plan

Fig 9: Hostel – Warananagar – View of opened out corner

(IIb) Another variation to the second technique

Passageway surrounding a narrow green space can be further spruced up by clever Zig-Zagging of the circuitous passage and even adding a mid-connecting crossing. If contours allow, level differences in the plinth can add more delight (See Fig 10, 11).

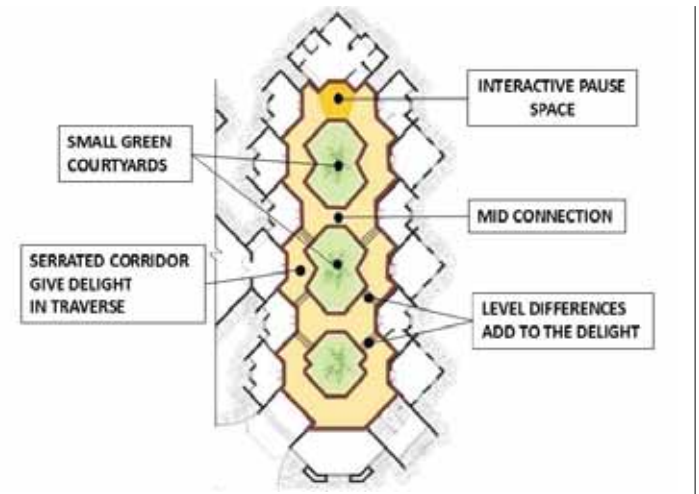

Fig 10: Hostel - Dental College, Belgaum – Zig zag corridor plan

Fig 11: Hostel - Dental College, Belgaum – View of zig zag corridor

Meandering of passage promotes a deliberate, slower movement giving time to view the adjoining green space or lobby.

Statuary with a difference: people participating sculpture that is located in a circulation space can also add enchantment (See Fig 12).

Fig 12: Warana Military Academy, Warananagar – participatory statuary

'Floating' Corridor

I have been using the concept of "floating corridor" for some thirty odd years in my projects. A 'floating' corridor is created, when such a corridor is purposely distanced from side walls by about four meters space to create many benefits. Usable room zones are placed on either side, but apart, separated, from the departmental corridor. The rooms have now an advantage of wind and space flow on either side as well as daylight entry through the atrium. This 'Floating' corridor affords light and cross ventilation and segregates 'moving' and rooms entering traffic. Hence, walking along such corridors is full of delight and surprise. The example shown is from Dental College, Belgaum (See Fig 13,14,15).

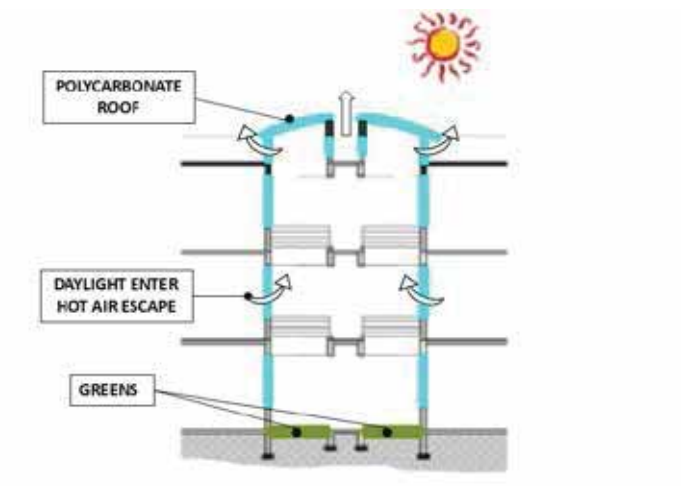

Fig 13: Floating Corridor - typical section showing light and cross ventilation

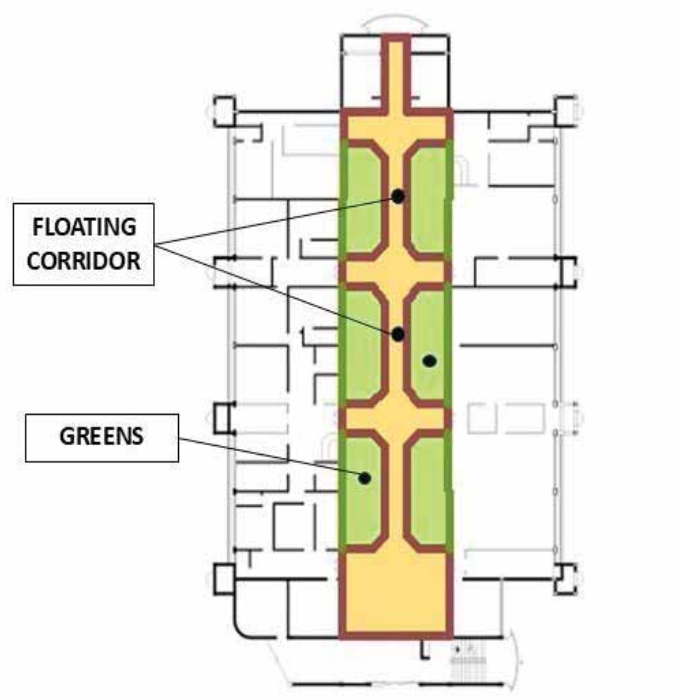

Fig 14: Dental College, Belgaum – Floating corridor plan

Fig 15: Dental College, Belgaum – Floating corridor view

CONCLUSION:

The age old definition of Architecture by none other than Vitruvius states three major parameters of Architecture: Utility, Firmness and Delight. Out of the three 'delight' is the 'raison-d'etre' of the Architectural spaces be they be usable spaces or circulation spaces. To reiterate, various circulation spaces need to create a 'celebrative' traverse.

With a little "Lateral Thinking" and "Thinking out of the box", one can add that emotive value to the traverse, leading to developing techniques that weave a delightful quality in various circulation spaces.

All Photographs courtesy the author

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ARTICLE

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Evaluating Urban Livability in the Adaptively Reused Heritage Structure of 'Mangalabas' in Historic Old Dhaka

By Simita Roy, Mohammad Tahajibul Hossain, Gourab Kundu, Brishti Majumder, and Rafia Rukhsat

1. Introduction

Old Dhaka, a thriving pre-colonial city and Bengal's political and economic center for four centuries, features numerous residential structures. These buildings, constructed across different eras, showcase distinct architectural styles representative of their respective historical periods. (Huq et al., 2017). Due to political changes, partition, and migration, many buildings in Old Dhaka have been abandoned, experienced ownership changes, or come under government control. These structures have been repurposed for residential, commercial, manufacturing, and warehouse uses. Rapid urbanisation and neglect have caused significant deterioration, with many buildings in disrepair due to age and lack of maintenance. The demand for new housing and commercial spaces has led to encroachments and unauthorised alterations, compromising structural integrity and historical authenticity, and disrupting the traditional urban fabric. Numerous buildings are privately owned by families who do not possess the means for required repairs, and awareness of their cultural value remains insufficient (Ali, 2017).

Preserving the historic buildings allows us to pay tribute to the skill, architectural excellence, and historical importance that they embody (Bullen & Love, 2011). Effective adaptive reuse ensures livability while supporting cultural preservation, sustainable urban development, and economic growth. These structures enhance community identity and social cohesion by serving as hubs for cultural activities and events. Moreover, adaptive reuse promotes both socio-cultural and environmental sustainability by reducing the need for new construction and minimising waste, while providing aesthetically unique environments that improve urban life (Bullen & Love, 2009) (Conejos et al., 2013). This approach harmonises historic charm with modern functionality, benefiting future generations. Inconsistent enforcement of government regulations for heritage conservation has led to inadequate preservation practices for historic buildings in Old Dhaka. Although non-governmental organisations actively support restoration efforts, these initiatives are frequently constrained by a lack of funding and resources.

Despite extensive research on the architectural features and preservation of historic buildings in Old Dhaka, there is a notable gap in studies on their livability in these structures. Understanding how these buildings are used is essential for identifying key preservation factors. Analysing their livability provides insights into necessary functional adaptations and modern requirements, ensuring their relevance and sustainability in contemporary urban contexts (Bullen & Love, 2011). This approach will support the development of effective conservation strategies that maintain both the cultural significance and practical usability of these buildings.

This study demonstrates how adaptive reuse of old buildings ensures their livability, making them affordable and functional in contemporary urban settings. It emphasises the significance of creating urban spaces that honor historical value while addressing current needs through effective and relevant adaptive reuse strategies.

1.1 Aim and Objectives

The study investigates and evaluate how adaptive reuse of historical buildings embodies cultural heritage and its influence on the livability in Old Dhaka. To achieve this aim, three objectives have been established:

1. To investigate the aspects of urban livability within historic mansions;
2. To explore the relationships and networks influencing individuals' lives and spatial choices; and
3. To evaluate how space and networks contribute to the establishment of cultural representation within dense multifamily residences devoid of designed amenities.

2. Literature Review

This literature review analyses livability concepts and Old Dhaka's context to assess the Multicourt Mansion, *Mangalabas*, integrating theoretical and historical perspectives to inform contemporary urban livability discussions.

2.1 Urban Livability

Cities are intricate systems comprised of numerous interconnected elements. The relationships among physical components—blocks, plots, streets, buildings, trees, trails, furniture continually evolve, reshaping urban life. Spatial patterns of urban form emerge from these relationships, influencing urban livability. Livability, interpreted as the quality of the person-environment relationship, offers a lens to understand urban systems and their components. It pertains to an urban system that enhances physical, social, and mental well-being. Evaluating livability, however, is complex, as individual perceptions of the urban environment vary over time and across different contexts. Heylen (2006) defines livability as the individual's environmental perspective and housing quality evaluation. Throsby (2005) highlights tangible features like infrastructure and intangible elements such as social networks and cultural capital. Kovács-Győri (2019) addresses livability through spatial aspects (tangible features), temporal aspects (dynamic factors like needs and preferences), and personal aspects (subjectivity and individual choices). Vergunst's (2003) framework evaluates livability through five components: inhabitants, community life, local economy, physical place, and services. These frameworks collectively emphasise the multifaceted nature of livability, considering both objective and subjective factors that influence urban environments and residents' quality of life. With the view of the literatures the dimensions of livability (Figure 1) can be categorised as follows:

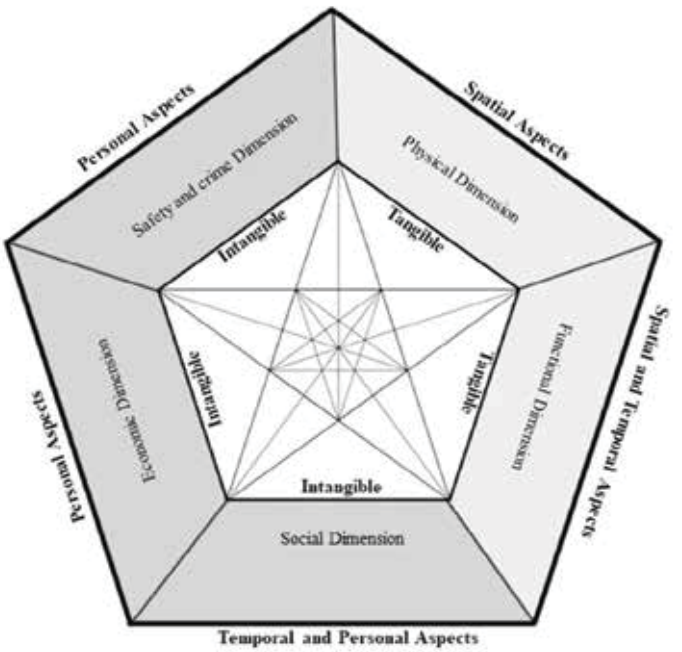

Figure 1: Aspects of Livability
Source: Author

· Physical Dimension

The physical environment, where individuals work, live, and form social networks, profoundly impacts perceptions and feelings. Conditions such as pollution, litter, noise, and congestion influence interactions with space. While most studies emphasise parks and green spaces, fewer address overall environmental quality. Heylen (2006) includes amenities and services under this dimension, whereas Omuta (1988) separates them. Malaysian studies group physical and functional indicators under social and public facilities (Osman et al., 2004).

· Social Dimension

Indicators for this category assess the status and relationships of social elements, focusing on community life and social contact. While Omuta (1988) separates neighbors' behavior as a distinct dimension, the sense of place, linked to neighborhood satisfaction, is also significant. Local studies identify social indicators such as moral support from neighbors and friends and mutual aid (Omar et al., 2005). Through a literature review, the

social dimension of livability encompasses several parameters: nature of social relationships, level of activities and interactions, personal freedom, community pride and attachment, sense of ownership and belonging, and acceptance of diverse cultures and racial harmony.

· Functional Dimension

As noted by Akin & Okanlawon (2017), functional indicators of well-being include the provision and location of communication systems, shops, kindergartens, clinics, schools, and other services. Both private and public service availability is crucial for local evaluations of neighborhood quality. Additionally, accessibility to public transport and highways, and employment opportunities are key factors. Employment not only provides income but also fosters social networks, societal involvement, and psychological satisfaction through personal achievement.

· Economic Dimension

The economic dimension of livability encompasses factors such as affordability, economic stability, and the availability of employment opportunities. It assesses how economic conditions and opportunities influence residents' quality of life, accessibility to essential services, and overall economic sustainability within a community or urban setting.

· Safety and crime Dimension

Safety is a fundamental need, as everyone desires to live in a crime-free and secure neighborhood. A high crime rate creates an unsafe environment that instills fear and anxiety among residents, undermining overall quality of life despite other satisfactory conditions. Savasdisara (1998) identifies safety and security as key predictors of satisfaction with living conditions in Japanese urban communities. Indicators for the safety dimension include the frequency of crimes (homicide, property crime, and sexual assault), incidents of injuries or accidents, and residents' feelings of security.

2.2 Mansions of Dhaka during the Colonial Period

The evolution of house forms in Bengali architecture has been significantly influenced by societal, cultural, and climatic contexts, yet certain spatial arrangements, notably the courtyard, persisted until the colonial period. The courtyard played a crucial role in traditional Bengali houses and their adaptation to urban contexts, particularly regarding the utilisation of public spaces for social and religious programs. Traditional Bengali houses typically consisted of inward-looking rooms or huts arranged around a central courtyard, facilitating various household functions and activities. The courtyard served as a transitory space, social hub, religious area, climate modifier, and domain divider. The segregation of spaces adhered to a bi-polarity principle, demarcating public and private, formal and informal, and other opposing domains, ensuring both functionality and privacy.

In rural settings, the courtyard was central to socio-cultural activities. Multiple courtyards often indicated extended families, with each unit associated with a single courtyard, replicating the traditional pattern of rooms and activities. The public part of the house, usually facing an outer court, was dedicated to social activities and formal gatherings, reinforcing social cohesion and cultural practices. Urbanisation led to adaptations of this traditional form. In Dhaka, rural houses were replicated on smaller urban plots, resulting in a compact, introverted house type that retained the courtyard arrangement. Despite variations, the courtyard remained a prominent feature, supporting urban socio- cultural needs.

During the colonial period (1765-1947), European architectural styles led to hybrid forms blending local and foreign elements, resulting in bungalows and mansions. These structures adopted European facade elements while retaining internal courtyards for functionality and climatic reasons. Public parts of these houses, particularly courtyards, played a crucial role in social and religious activities, reflecting the household's social aspirations and status, while accommodating traditional practices within urban living conditions (Rahman & Haque, 201).

History of Mangalabas

The *Mangalabas* mansion, a heritage edifice in Old Dhaka, offers a compelling subject for academic study due to its layered history and varied adaptive reuse. Originally owned by local landlord *Jatindra Kumar Saha* and situated near the Buriganga River, the mansion's exact construction date remains undocumented. However, from the field survey, its architectural features suggest a colonial origin (predominantly neo-classical architectural style) with multiple construction phases spanning several generations and modifications by successive occupants. A notable aspect of the mansion's construction is the use of wooden beams in its western wing, indicating a period predating the widespread adoption of cast iron components. This suggests that this section was built before the British introduced railways and associated building materials to the Indian subcontinent. In contrast, the section currently used as a student dormitory

incorporates cast iron elements, reflecting an early adoption of steel components.

The spatial organisation of *Mangalabas* is particularly interesting, showcasing a clear distinction between public and private areas. The mansion's facade features heavy square piers and a grand entrance foyer marked by a convex podium leading to a large verandah flanked by public rooms. This verandah provides access to a living room, beyond which a corridor runs around the main inner court. Figure 2 shows the symmetrical arrangement in the formal parts transitions to a more irregular layout in the private areas. The house comprises four inner courts, each serving distinct functions. The main court is separated from a secondary family court by a stair used exclusively by women. Another court, with an independent entry, is located at the northwest corner for public and official functions. The southwest court serves as a subsidiary area for services, caretakers, and servants. The principal access road to the north is narrow and currently runs very close to the house, suggesting it may have initially been further north to allow a full view of the facade.

Figure 2: Previous and Present use of Mangalabas
Source: Author

2.3 Adaptive Reuse of Heritage Structures

Adaptive reuse of heritage buildings involves repurposing historic structures for new uses while preserving their cultural, architectural, and historical values. This approach integrates financial viabilityto establish a sustainable economic solution for protecting heritage buildings, avoiding demolition and new construction. The theoretical foundations include sustainability theory, architectural conservation theory, place theory, and circular economy theory.

Sustainability theory encompasses environmental sustainability by reducing the carbon footprint through minimised use of new construction materials (Bullen & Love, 2011). It also supports cultural sustainability by maintaining cultural identity and historical continuity (Plevoets & Cleempoel, 2011) and economic sustainability by leveraging existing assets, proving cost-effective compared to new construction (Conejos wt al., 2013) Architectural conservation theory focuses on maintaining the architectural integrity and historic value of heritage buildings (Feilden, 2003). Place theory suggests that adaptive reuse strengthens community ties by retaining familiar landmarks (Relph, 1976). Circular economy theory promotes continuous use of resources, aligning with adaptive reuse by extending the life cycle of heritage buildings and reducing waste (Webster, 2015).

Adaptive reuse can include mixed-use development, cultural or community functions, commercial ventures, educational facilities, residential spaces, or hybrid models. Mixed-use development maximises space utility and revitalises urban areas (Langston, 2012). Transforming heritage buildings into museums or cultural hubs facilitates public engagement with history (Pendlebury, 2012). Despite challenges such as regulatory issues, structural challenges, and financial viability adaptive reuse offers a sustainable approach for historic building preservation and urban development (Pendlebury, 2012; Brand, 1994: Shipley et al., 2006).

2.4 Adaptive Reuse of Mangalabas

Following the partition in 1947, *Mangalabas* was abandoned and occupied by many landless people. Later on, this mansion came under the jurisdiction of the District Commissioner's (DC) office. After Bangladesh's independence in 1971, the DC office leased areas of the western wing as rentable properties to local residents, while the eastern part, including the main structure, was leased to the Kabi Nazrul Government College for use as a student dormitory. This unplanned adaptive reuse is notable given the scarcity of historic mansions repurposed for residential use in Dhaka, where most are converted for commercial purposes.

The western wing currently accommodates 15 dwelling units occupied by members of the Hindu community. This adaptive reuse aligns with place theory, as it retains the building's residential function, highlights community ties, and integrates courtyards as public spaces. However, economic sustainability is lacking, as rental income is insufficient for maintenance. User-driven modifications include adding essential services, altering openings, and introducing modern utilities. Communal ritual

spaces and dwelling units in the courtyards indicate incremental adaptation over time. Although architectural integrity is compromised, the building's historicity remains traceable.

The surrounding streets and a large field serve as informal social spaces. Children use these areas for outdoor activities, while adults engage in informal conversations. Inhabitants share service elements, maintaining cleanliness together. Despite increased density and additional service elements, communal courtyards facilitate interaction, especially among women. The densely populated area, with urban amenities within walking distance, fosters security and contributes to a low crime rate.

3. Methodology

Mangalabas was chosen as a case study because its current residential use closely mirrors its original function. A mixed-method approach was adopted, involving an analysis of building components repurposed for residential purposes. This methodology included conducting interviews and site visits to gather detailed insights into the adaptive reuse process and its impact on livability. The following three aspects has been investigated through following steps (Figure 3):

Aspects	Dimensions	Parameters	Analysis
Spatial aspects	Physical Dimensions	More tangible Accessibility	Detailed building diagnostics
		Physical Features	Sketch based documentation
		Spatial Organizations	Depth map analysis
Temporal Aspects	Functional Dimension	Dynamic factors,	Household Satisfaction survey
		Residents' needs/ preferences. Expectations (Individual level),	Structured and semi-structured interview
		Human needs,	SPSS analysis
		Personal values.	
Personal Aspects	Social Dimension	Level of subjectivity, Individual preferences/ Perception,	Household Satisfaction survey
	Safety and Crime Dimension	personal choices,	Structured and semi-structured interview
		Perceived density	SPSS analysis

Figure 3: Methodology
Source: Author

Total Fifteen (15) number of people from fifteen (15) families and six (06) students from the dormitory by random sampling have been interviewed to have a firsthand understanding of phenomenon and to ensure data integrity. Interviewer was as non-intrusive as possible to allow participants the freedom to present their own meanings of livability. Participants' responses were analysed in terms of their perceptions of satisfaction and the temporal use of space within the heritage structure. To address the first objective, detailed building diagnostics were conducted through observational studies and technical inspections, including sketches, structured and semi-structured interviews, and drawings. The data collected from the field were subsequently analysed using SPSS and Space Syntax methodologies. The research has the limitation of not fully addressing the complex evolution process of the mansion to its present condition. However, the paper does provide a detailed case history of a family residing in this building for almost 80 years, offering valuable insights into the adaptive reuse of historical structures and their cultural representation in Old Dhaka.

4. Data Analysis and Findings

4.1 Spatial Aspects

Mangalabas is a multi-court mansion, with courtyards serving as the focal point for household and socio-cultural activities. Historically, this mansion accommodated multiple generations of the same family. According to Rahman, 2003, the spatial arrangement of *Mangalabas* adheres to formal, family, and service-oriented functions centered around the courtyards. Like other multi-court mansions in Old Dhaka, it features distinct male and female domains, a formal entrance portico, and a service entry. The zoning within the mansion varies according to use, encompassing formal-public, family-private, and service areas. The mansion comprises four inner courtyards, with a women-only stair separating two courtyards (C3 & C4), now part of a student dormitory. The rooms surrounding the second courtyard (C4) are small and do not directly connect to the main courtyard and hall rooms. Another courtyard (C1), located at the northwest corner and now part of a multifamily residence, has a separate entry and was used for public and official functions. The southwest courtyard (C2) served as a subsidiary area for service, caretakers, and servants. The upper floor replicates the spatial arrangement and grouping of the ground floor (Figure 2).

Alteration and Adaptation

When the mansion transitioned into a multi-family residence and hostel, several alterations and negotiations took place. The hostel section's usage aligns closely with the mansion's original spatial configuration, characterised by a modular distribution of residential spaces and service units at the rear. Consequently, this area experienced adaptation rather than extensive modification (Figure 3). The students' residential units are arranged around the central inner courtyard, while staff and their families live in newly constructed units in the backyard. Washrooms and bathing areas are located around service court No. 04, with the kitchen and common dining area situated beside court No. 03,

acting as a buffer from the multi-family residence in the western part (Figure 2).

The western section of the mansion has undergone significant alterations and additions. Originally used for public and official functions, it is now predominantly residential, with all units rented. Approximately 80 years ago, this section began operating as a rented residential property for families. Interviews with the fourth-generation resident of the initial dwellers revealed that the section was initially rented by four brothers from the Dhaka DC office. Currently, fifteen families reside on the premises, though not all are descendants of the original residents. Our survey identified one inheritance still residing in the property, with the evolution of their dwelling space detailed in Figure 5.

Alteration and Adaptation Addressing Incremental Growth

Within the previously established boundaries, the incremental growth of multigenerational living has been addressed through the addition of living units and shared services. Figure 2 demonstrates that the overall living unit area of this premise is 60-72 square feet, meeting minimal spatial requirements for sleeping and storage. Currently, dining typically takes place on the bed; however, approximately 40 years ago, there was a separate common dining facility for all residents. To accommodate this living space, large rooms and spacious circulations from the past have been subdivided with easily moveable temporary partitions.

When incremental growth necessitates accommodating the second generation, they typically rent additional living units with shared services. Our survey revealed an intriguing example of age-wise space distribution to manage limited spaces. Older residents usually reside beside passages with less privacy, while younger generations occupy more private areas to avoid visibility (Figure 5a). These locations have been verified using visibility graph analysis of Space Syntax (Figure 8). This approach underscores how spatial configurations adapt to the evolving needs of multigenerational living.

To illustrate the evolution of multi-generational inheritance within *Mangalabas*, we conducted a detailed investigation of *Joy Sarker's* dwelling pattern, the only descendant of the primary residents. Approximately 80 years ago, *Joy*'s great-grandparents began residing in this property. Initially, they utilised the service blocks located in the backyard and lived in the frontal section with a courtyard, adhering to the traditional spatial uses.

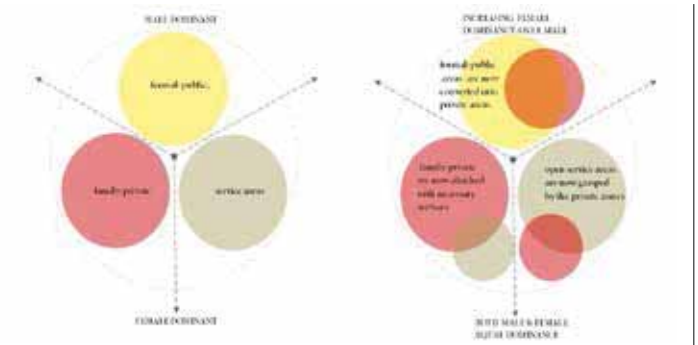

Figure 4: Adaptation and Alteration at Mangalabas
Source: Author

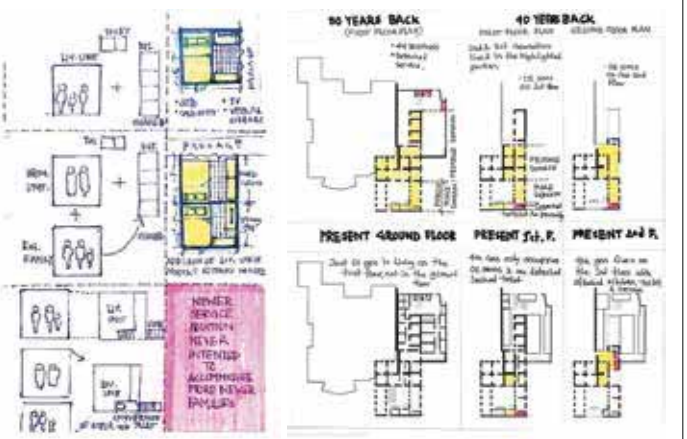

Figure 5: Alteration and Adaptation Addressing Incremental Growth
Source: Author

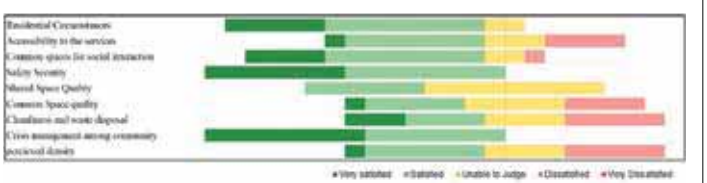

Figure 6: Household Satisfaction Survey Results
Source: Author

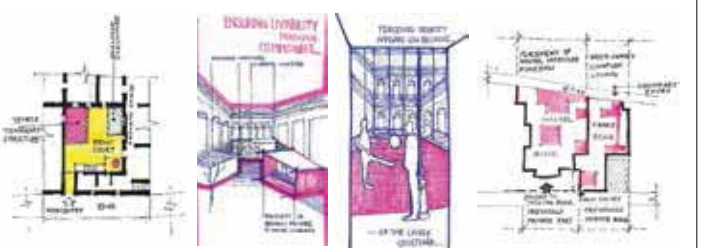

Figure 7: Commoning creates more livable context
Source: Author

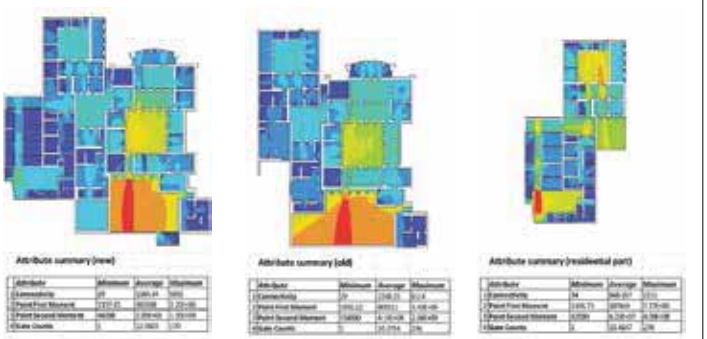

Figure 8: Visibility Analysis
Source: Author

Over time, as some descendants moved out, other families began renting the vacant rooms. According to Joy's account, parts of the building were developed to accommodate additional families (Figure 5b) with shared facilities such as kitchens, dining areas, toilets, and a temple.

The *Sarker* family utilised these shared services until elderly family members, residing on the first floor, became unable to access the ground-floor facilities. Initially, *Joy*'s grandparents converted a stair into two toilets on the first floor for convenience. Subsequently, other families followed suit, adding similar toilets in various locations throughout the building. Currently, the *Sarker* family lives on the second floor with separate kitchen, toilet, and terrace facilities, and they also retain two living rooms and one toilet on the first floor (Figure 5b). This case study underscores the adaptive changes in spatial arrangements to meet the evolving needs of multi-generational living, highlighting the dynamic nature of residential adaptations in response to family requirements.

4.2 Temporal Aspects

To interpret the mansion's temporal aspects, we interviewed residents from fifteen families using random selection. We combined responses across age groups and genders to understand their navigation, negotiation, and adaptation within the building. A household satisfaction survey, with structured and semi-structured questions, assessed satisfaction with residential circumstances, service quality, social interaction, safety, and community sense. Objective questions used a Likert scale, while subjective questions explored reasons for residing in or leaving the building. The survey data has been represented in the Figure 6 and Figure 10.

Shared spaces and Social Interaction

Social interaction significantly enhances quality of life. Despite compact living units, courtyards and adjacent fields facilitate social and recreational activities, making the building more livable. Courtyards, verandas, common corridors, and terraces provide accessible environments for socialisation (Figure 7b). Older individuals and women predominantly use common spaces in residential areas, while students interact in dining halls, courtyards, and verandas in hostels. 80% of interviewees expressed high satisfaction with shared spaces for social interactions, though only 50% were satisfied with their quality (Figure 6).

Cultural Activity spaces

In '*Mangalabas*', the courtyard serves as a cultural activity space, providing a flexible environment for meetings and celebrations. Since all inhabitants are Hindu, they built two common temples in the courtyards of the western part of the mansion. Fifty years ago, a common temple was constructed in the backyard, where all shared services are located. Ten years ago, another small temple was added in the front court to prevent future expansion of dwelling units into the open space (Figure: 7a). The residential satisfaction survey shows that, the inhabitants are mostly satisfied with common space quality and use these spaces for religious festivals and social events, fostering mutual understanding and respect, and enhancing the quality of life by providing convenient access to cultural and recreational activities.

Depth Map discussion, visibility study and Age-Wise Space Distribution

The Depth Map, a tool from Space Syntax, is employed to analyse spatial layouts and their impact on social behaviors within built environments. It aids in identifying social spaces and their connectivity. In this case, the tool was used to identify social spaces that developed spontaneously based on visibility and connectivity within the building. We found spaces with high visual access and connectivity, often preferred for social interaction and safety, including by the elderly and children who require more attention. This spontaneous spatial response enhances residential safety and security. Higher connectivity typically indicates a space is well-integrated within its local context.

The visibility graph analysis shows that '*Mangalabas*' currently has less connectivity compared to its past. Historically a private residence, the space surrounding the inner courtyard was highly connected to the courtyard. However, to accommodate new functions, the building has been compartmentalised, resulting in less connected spaces. Figure 8 illustrates that the courtyard and passage are more connected than the family residences, which are spaces of high connectivity and integration for social interaction. Interviews corroborate that adults prefer a mix of well-integrated spaces for work and leisure. Studies suggest that elderly individuals favor spaces with low depth values, high visibility, and good connectivity for safety and ease of movement. Elderly residents in these buildings prefer rooms connected to the common passage, as shown by depth map analysis, indicating these rooms have low depth values but high visibility.

4.3 Personal Aspects

Sense of Community

The shared spaces and common services in this building significantly strengthen the sense of community among residents, encouraging interaction, collaboration, and collective activities. The thoughtful adaptation of these spaces fosters social cohesion and improves well-being for all members. This enhanced sense of belonging and community also contributes to increased safety and security. Notably, 100% of the interviewed residents expressed satisfaction with the community's safety, security, and crisis management capabilities, highlighting the effectiveness of these communal spaces in promoting a supportive and secure living environment (Figure 9).

Individual preferences and personal choices

In our survey, two subjective questions were posed to all interviewees to understand their motivations for residing in or leaving the building. Findings indicate that affordability and a strong sense of belonging are primary reasons for remaining in this residence. The comparatively low rent, despite substandard living conditions, plays a significant role in residents' long-term tenure, with many having lived here for over three decades. However, 80% of respondents indicated that an increase in house rent might prompt them to leave this property, although some residents consider leaving to improve their standard of living with better economic conditions. Security and proximity to workplaces were also noted as critical factors influencing their decision to stay, underscoring their commitment to the property (Figure 9).

Perceived Density

The communal use and careful scheduling of space (Figure 10) effectively mitigate the perceived density within this building. By encouraging shared utilisation

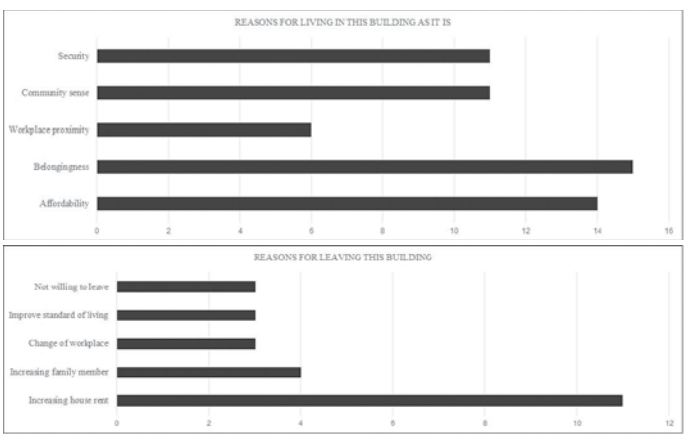

Figure 9: Personal aspects' reflection found from the survey
Source: Author

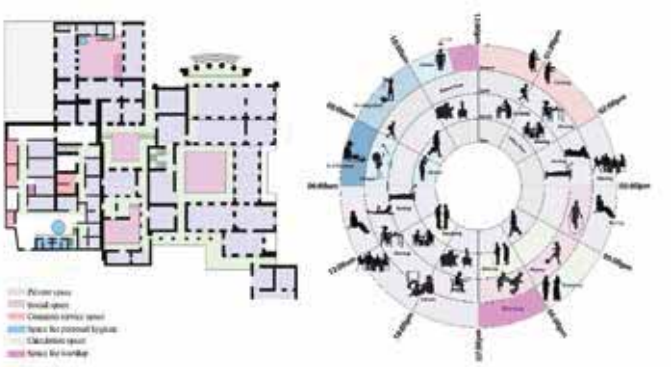

Figure 10: Activity map with time schedule
Source: Author

and strategic timing of spatial activities, such as communal gatherings or staggered use of facilities, residents experience a reduced sense of crowding and congestion despite the physical density of the built environment. This approach not only optimises the functional efficiency of shared spaces but also enhances the overall livability by fostering a sense of spaciousness and comfort among inhabitants. Thus, through deliberate communal practices and thoughtful management of space, the perceived density is effectively minimised, contributing to a more pleasant and harmonious living environment.

5. Conclusions and Recommendations

The research indicates that affordability is a critical factor influencing the livability of adaptively reused heritage buildings. In the context of *Mangalabas*, affordability often overshadows other aspects of livability, such as space and comfort, suggesting that economic considerations are paramount for residents. This finding underscores the importance of cost-effective solutions in maintaining the relevance and usability of historic structures.

Additionally, the extended daily use of the building contributes to a perceived lower density among residents. Despite the high occupancy levels, the continuous and varied daily activities within the building create a sense of spaciousness. This perception is significant because it affects residents' experiences and satisfaction with their living environment, demonstrating how daily usage patterns can influence perceptions of livability.

Moreover, the research reveals that the addition of service units within the building is primarily driven by considerations of accessibility and proximity rather than the expansion of family units. The strategic placement of service units—such as kitchens and toilets—seems more related to their convenience and ease of access for residents rather than the specific needs of growing family sizes. This finding

highlights the adaptive strategies employed to address practical needs and improve living conditions without substantial structural changes.

In summary, these findings suggest that while affordability remains a dominant factor in the livability of heritage buildings, daily usage patterns and strategic placement of service units play significant roles in shaping residents' experiences. Understanding these dynamics provides valuable insights into the effective adaptive reuse of historical structures, ensuring they meet contemporary needs while preserving their cultural and historical significance.

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ARTICLE

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Understanding the Needs of Spatial Organisation for the Liminal Zones

The Red-Light Districts of Mumbai, Pune and Delhi

By Shrutik Gaoture and Karishma Kaur Hooda

1. Introduction:

Red Light Districts in India are often stigmatised and marginalised taking the shape of urban heterotopias that co-exist with the societal belief systems. The current state of these areas is a testimony to all patterns of formal and informal sex trade in the country. The British colonial period marked a significant shift in the perception and regulation of prostitution. The British introduced the Contagious Diseases Acts in the late 19th century, aimed at controlling venereal diseases among British soldiers. These Acts allowed for the registration and regular medical examination of prostitutes, which was met with resistance and criticism from Indian reformers. Although the upbringing of every Red Light District and operational patterns vary across the country, they end up in deteriorated physical infrastructure, social acceptance and economic vulnerability.

Kamathipura in Mumbai, Budhwar Peth in Pune and G.B. Road in Delhi are identified as the prominent Red Light Districts of the country's metropolitan cities. Kamathipura, established during the British colonial era, is one of the oldest red-light areas of India. Its labyrinthine lanes are filled with a dense population living in cramped conditions, reflecting a long history of neglect and marginalisation. Despite its deteriorating infrastructure, Kamathipura continues to be a significant hub of informal economic activity, supporting the livelihoods of thousands of sex workers and their families. Efforts to redevelop Kamathipura have been met with mixed reactions, as residents and activists stress the importance of protecting the rights and well-being of the sex worker community. Though its spatial identity crisis has negatively impacted local residents that coexist parallel to a Red Light District that is bound to be a victim of gentrification in the conflict of infrastructural development.

Budhwar Peth in Pune has a historical significance, with roots tracing back to the Peshwa era. It evolved from a vibrant commercial hub of the city's Peth area into a marginalised enclave, characterised by old, partitioned wadas and congested streets. The social stigma attached to Budhwar Peth is severe, impacting the residents' access to essential services such as healthcare and education. Despite these challenges, local NGOs have been actively working to provide support and improve the living conditions of the sex workers and their families. However, integrating Budhwar Peth into the city's broader urban planning framework remains a significant challenge, requiring a balance between redevelopment and the preservation of the community's social and cultural fabric.

G.B. Road, officially known as Swami Shradhanand Marg, is Delhi's most notorious red-light district. Its central location, close to major transportation hubs, underscores the paradox of its existence: a bustling economic zone that remains marginalised and neglected. The multi-story brothels and narrow alleys of G.B. Road conceal a complex social structure

where sex work, commerce, and everyday life intersect. Efforts to reform G.B. Road have included legal and social initiatives aimed at improving the rights and living conditions of sex workers. However, these efforts often clash with entrenched societal prejudices and regulatory challenges, complicating the path towards meaningful change.

The stakeholders of each area define the very character of the Red Light District where the frame of image is not only the prostitute but the customers as well as the neighbouring locality. Prostitution in G.B Road is a product of human trafficking and by force prominently as compared to poverty or unemployment. In this scenario, the majority of the brothels operate pimping administration diverting it towards the criminal aspect of prostitution. Kamathipura on the other hand portrays a moderate ratio of human trafficking and poverty or unemployment. On the contrary, Budhwar Peth, being the centre of the city shows minimal human trafficking cases and brothels majorly operated on a rent-based manager system since after the raid of 2014 when brokering almost came to an end.

2. Aim and Objective:

The aim of this research paper is to explore and understand the necessity of spatial organisations in red light districts with a focus on enhancing the quality of life for the stakeholders, including sex workers, residents and local businesses. This seeks to provide insights into how critical and inclusive urban planning can address the socio-economic and infrastructural challenges faced by these marginalised communities. The objective directs the research to examine the current state of infrastructure, living conditions and socio-economic dynamics within Budhwar Peth, Kamathipura and G.B.Road.

Identifying the critical challenges related to spatial organisation, including adequate housing, poor sanitation, lack of healthcare and educational facilities and social stigma pictures the identity of the space. The research paper evaluates the different aspects of spatial design and urban planning impacting the daily lives and power play between the stakeholders. It fosters awareness and advocates for policy changes that support sustainable and inclusive urban development.

3. Literature Review

The architectural development and planning of red light areas in India is a multifaceted issue that intersects with historical, social, and economic dimensions. Smith's *"The Urban Experience: A Study of Red Light Areas in Indian Cities"* provides a comprehensive historical overview, highlighting how colonial and post-colonial policies have contributed to the spatial and socio-economic characteristics of these areas. This historical context is critical for understanding the entrenched nature of the challenges faced by red light districts and underscores the need for informed and sensitive urban planning.

Ananya Roy's *"Red-Light Districts: India's Modern Urban Scourge"* delves into the contemporary issues plaguing red light areas, such as poverty, inadequate infrastructure, and social stigma. Roy's analysis emphasises the need for holistic urban planning strategies that address both the physical environment and the socio-economic conditions of residents. The book highlights the failures of past interventions that did not consider the socio-cultural dynamics of these communities, leading to unsustainable and ineffective solutions.

Roy advocates for a participatory approach in urban planning, involving local communities in the decision-making process to ensure that interventions are contextually appropriate and sustainable.

Arjun Kumar's *"Resilient Urban Spaces: Planning for Social and Economic Inclusion"* offers a forward-looking perspective on how to create inclusive and resilient urban environments. Kumar's work is particularly relevant for the architectural and planning challenges of red light areas, as it focuses on strategies that promote social and economic inclusion. He discusses various case studies where inclusive planning has led to significant improvements in living conditions and social cohesion. Kumar emphasises the importance of integrating informal settlements into the formal urban fabric through innovative architectural designs and inclusive policy frameworks. His work suggests that resilience in urban planning can be achieved by addressing both physical and socio-economic vulnerabilities, thereby creating environments that are adaptable to change and supportive of all residents.

Combining insights from these works, a comprehensive approach to the development and planning of red light areas in India emerges. It involves understanding the historical context, acknowledging contemporary socio-economic challenges, and applying inclusive and resilient planning principles. Effective interventions must be multi-dimensional, addressing not only the physical infrastructure but also the socio-economic and cultural aspects of red light districts. This integrated approach can lead to sustainable and humane urban environments that support the well-being and inclusion of all residents. As these authors suggest, a shift towards

participatory and inclusive planning, coupled with innovative architectural solutions, holds the promise of transforming red light areas into vibrant and resilient urban spaces.

4. Methodology

In order to examine the aspects mentioned above, the study is conducted through primary and secondary sources. The literature review directs the space narrative from social parameters to planning and development. The primary studies include on-site mapping, documentation and interviews with the stakeholders and general public of perception.

5. Data Analysis and Findings

Urban Studies allow for a deep understanding of the inner workings of such spaces and areas. The intent of this subsection is to have a deeper look into various stakeholders and users of these spaces and how they contribute to a unique & diverse street landscape.

5.1 Kamathipura: Traces of the Past

Kamathipura, located in Mumbai, has a multifaceted and challenging history. Originating during the colonial period, the area grew into a major red-light district due to the economic expansion driven by the Opium trade and textile industries. This economic growth attracted many migrants, including women looking for work, leading to the establishment of Kamathipura as a center for sex work. Even with laws against commercial sex, Kamathipura remained a "tolerated" zone due to its economic and social importance. Its notoriety for vice and crime highlights broader societal attitudes and the difficulties of managing informal economies in rapidly developing urban areas.

5.1.1 Kamathipura: Zoning & User Movement

The urban landscape of Red Light district Kamathipura is a combination of dainty small streets, very densely occupied with workers, street dwellings and hawkers. The dainty streets are occupied by potential customers where they are picked up by the pimps or women themselves. The urban landscape of Kamathipura entails mostly residential buildings used as brothels and shops at the bottom of buildings. Many residential buildings have brothel floors and residential ones, in a few buildings residential flats are shared with brothel rooms on the same floor. The streets are also full of hawkers selling shoes and street food. The roads are encroached by residential rooms on the ground floor with their necessities and sometimes by hawkers themselves. The Zoning of Kamathipura places it in Residential Zone with a few commercial plots used

Figure 1: Urban Map of Kamathipura
Source: Author

as small scale industries and a marketplace for cheap shoes. The area is also full of various dilapidated buildings throughout. Due to the mixed nature of the area which not only facilitates to sex workers but also to an entire market & an industry of FMCG, they overlap and merge in its varied looks of specific streetscape of Kamathipura. The area of Kamathipura is also known for its small scale FMCG (Fast Moving Consumer Goods) industry and it adds onto the user base that Kamathipura tends to attract. The streets of Kamathipura not only attracts customers for the sex workers but also traders, merchants and consumers of various necessities. This Kamathipura attracts people migrated from different parts of India, seeking economic opportunities or escaping difficult circumstances. Within Kamathipura, a social hierarchy exists among the sex workers, based on factors such as seniority, reputation, and the nature of their work. Experienced sex workers who have been in the industry for a longer time may hold more influence and respect among their peers. They may occupy more prominent positions within the brothels, have a larger clientele, or possess better living conditions. Madams or brothel managers play a significant role in the social hierarchy of Kamathipura. They are responsible for managing the brothels, overseeing the sex workers, and organising their work schedules. The relationship between

the madams and the sex workers can vary, ranging from exploitative to more supportive, depending on individual circumstances. It's worth mentioning that Kamathipura's social hierarchy and dynamics can be complex and multifaceted. Factors such as caste, language, and regional backgrounds may also influence the social interactions and hierarchies within the community. (Sonawane, 2023)

Kamathipura also faces an issue of gentrification, where the lower stake holders are to be excluded from the plans of development of Kamathipura. MHADA (Maharashtra Housing & Area Development Authority) has submitted and approved proposals for redevelopment of Kamathipura into a residential hub, completely wiping out the Sex worker industry. Gentrification creates a problem in relation to exclusion of the lower economics classes & diverts their development far from a more inclusive environment for co-existence.

5.2 Budhwar Peth: Traces of the Past

During the 16th and 17th centuries, Pune served as the centre of power for the Peshwa rule. The city was home to a significant population of knights, craftsmen, and businessmen. To cater to the entertainment needs of these men, a considerable number of dancers, musicians, and singers, primarily women, settled in Budhwar Peth. Initially, their role was solely to provide entertainment. However, over time, this form of entertainment gradually transformed into sex work, eventually establishing Pune's infamous "red light area." The origins of the present-day red light area in Pune can be traced back to a structure known as Bavan Khani, meaning "fifty-two chambers." Situated in the heart of the city, this structure dates back to the 18th century, as mentioned in the Gazetteer of Bombay Presidency in 1885. It represents one of the earliest references to brothel-based sex work in Pune. While prostitution did exist earlier, primarily in the form of mistresses and kept women, the introduction of Bavan Khani marked a significant shift towards a more transactional form of sex work, driven by monetary exchange rather than other forms of compensation. Bavan Khani aimed to establish a separate physical space for the institution of prostitution, targeting a lower section of society, particularly soldiers, rather than catering to the nobility (Saheli HIV/AIDS Karyakarta Sangh). It signified a shift from the previous "economics of kind" to an "economics of cash." The proliferation of brothel-based sex work extended from a location called Shukrawar Peth, gradually spreading into adjacent lanes. These interconnected lanes and by-lanes, housing the physical structures of sex work,

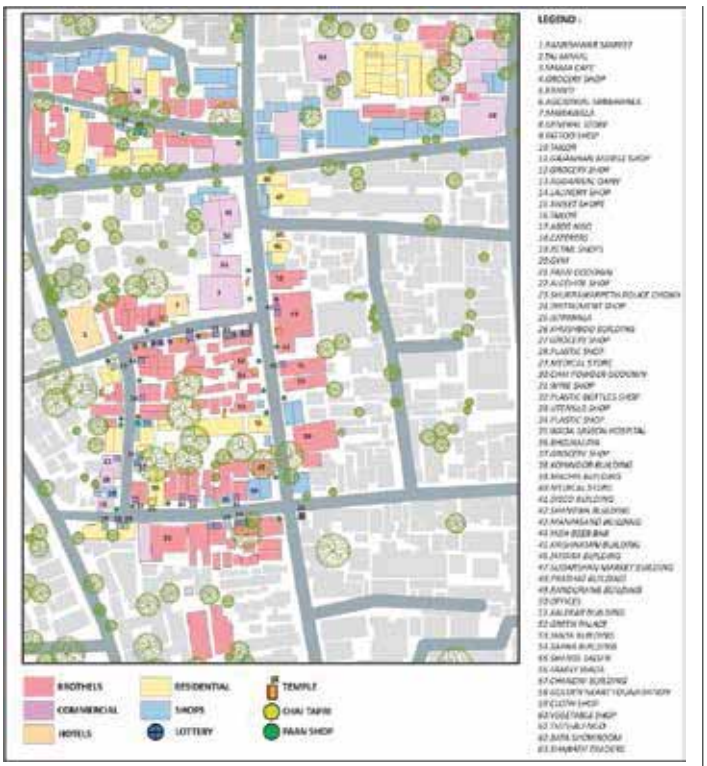

Figure 2: Zoning & Movement in Budhwar Peth
Source: Author

collectively form the red light area of Pune as it exists today. With time, the adjacent streets grew in size and became marketplaces for different goods. Pune experienced a surge in migration during the 1960s as industries prospered. The red light area is situated in the midst of a bustling marketplace, with most of the economy being composed of unstructured sectors and family-owned businesses.

The past of the red light district brings in the legacy of vernacular typologies, predominantly the wadas. The wadas are load bearing timber and brick structures that got adapted as brothels over time. Budhwar Peth identifies dynamic stakeholders from Devdasis to the Hijra community as non-generational prostitutes.

5.2.1 Budhwar Peth: Zoning & User Movement

The Budhwar Peth area is a significant hub for the distribution of electrical goods, books, and traditional products. Tambdi Jogeshwari Temple, N. M. V High School, Laxmi Road's main shopping district, Appa Balwant Chowk, and Dagadusheth Halwai Ganapati temple. Given the historical significance of Budhwar Peth, the tourism industry and related businesses are stakeholders. Most of the built structures are old, and all have about the same height, facing the streets, with narrow entrances and an open space within the buildings. Shops are on the ground floor and the subsequent floors are used for storage or residential

purposes. The wholesale market is divided into many parts and boasts of different trade at various lanes. Most of the NGOs are adaptive reuse structures that have developed in the area over time. Thithali NGO is a brothel converted into a school and baking centre.

The Laxmi divides the Red Light Area into two parts and is a busy mixed user road. Dambar Galli is part of the Red Light Area occupied by the Hijra community. It pulls the chain of wada style brothels along the lane. The lane shows less customer traffic as compared to other parts of the Red Light Area and is therefore equipped with small-scale community kitchen interventions and vegetable shops. Bata Galli is opposite to Dambar Galli where there are majorly RCC brothels organised in a mixed manner with other buildings. Dhane Ali Road is a major entry to the main Red Light Area where prostitutes from the other side of Laxmi Road also come in order to find customers. The left side of the lane is occupied by RCC brothels and the right side is occupied by wada style timber brothels. Devidasis also occupy wadas on this side.

5.3 G.B. Road: Traces of the Past

Delhi's G.B.Road has a history tracing back to the Mughal that still marks the skyline of the Shahjahanabad style architecture. The old city of Delhi, known as Shahjahanab was surrounded by the compound of gates and bastions. Garstin Bastion was located on the northern part of the city walls. It has been a centre for commerce and trade, which facilitated its evolution into a red light district.

Named after a Marathi word 'chawri' (meeting place), here, a 'sabha' would take place in front of a noble's home, who'd try settling matters. Another legend is that people used to gather here to see vaishyaas dance, giving them 'chavannis' and thus, the term 'chavannis' evolved to 'chawri'. There were five brothels in Delhi earlier. Garstin, a British commissioner, unified them into one red-light area. It was named after him: Garstin

Bastion Road/GB Road. "GB Road was named after Garstin. It was a place where 'mujras' happened. In fact, there were three places to view mujras from, for different classes- Qutub Road for lower, GB Road for middle and Chawri Bazaar for the higher classes (Hindustan Times, Pragya Gandhi, 2015).

Originally established during the British colonial period as a residential area for government officials, to a declared red light district, the current scenario portrays multiple modifications in the street over time. The retails of hardware and temporary structures like the stalls and tapris keep the

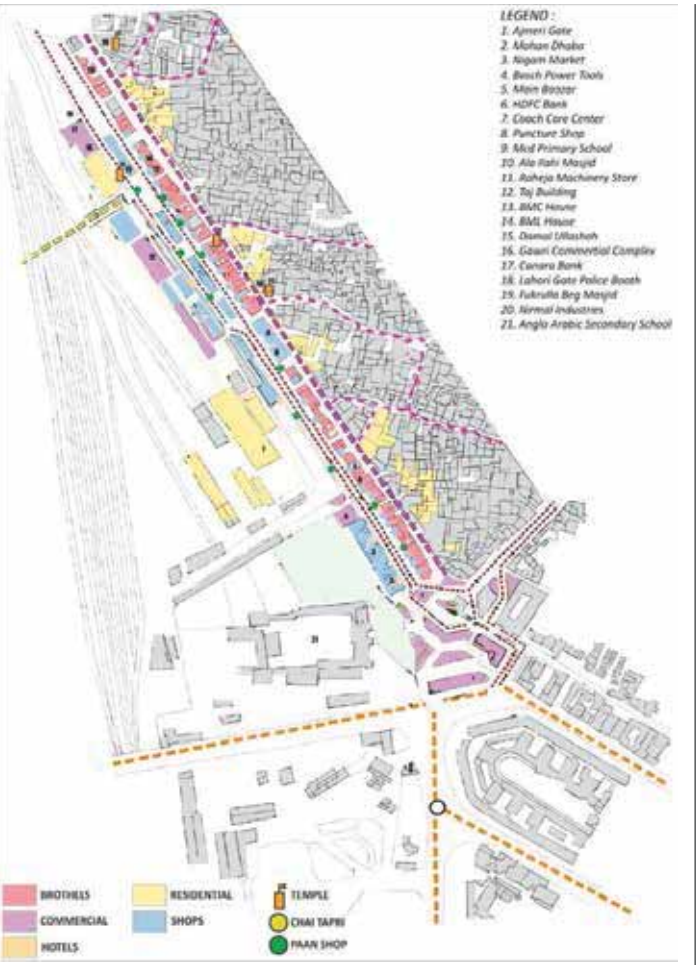

Figure 3: Zoning & Movement in G.B. Road Delhi
Source: Author

movement with changing ownership and activities on the road, the kothas on the upper levels hold back as the constant in the context as old dilapidated and unchanged elements of the area setting. Corresponding to this, a contrast in the regular shops and commerce is evident from the vertical zone edge of the sex-workers, marking a threshold from generic city activities. The upbringing of the surrounding chowks as market lanes and historic speculation pieces transforms a layer of a mixed-use locality that is co-existing with a red light district, economically and socially becoming both, a pull factor for the customer group of the brothel to avail the services of a sex-worker and a push factor for major residential occupancies that relocate elsewhere under the concern of safety and social-identity.

5.3.1 G.B. Road: Zoning & User Movement

G.B.Road, while better connected due to its central location, still faces issues related to infrastructure and service provision. The area is characterised by a mix of commercial and residential spaces, leading to a complex urban fabric that requires careful management. G.B.Road (Swami Shraddhanand

Marg, 1966) runs from the Ajmeri Gate to Lahori Gate, parallel to the railway lines is lined with two to three storey structures, with shops occupying the ground floor and brothels on the upper levels. These buildings are composed so close to each other, that brothel terraces connect to each other. The road is zoned with markets for machinery, hardware and automobile parts on the ground floor level. Shops line the ground level of the road segment that runs from the Ajmeri Gate in the south to the minor intersection with a street that leads up to Farash Khana in the north. Residential areas are the streets and homes behind the road. The opposite face of the street is occupied by NGOs, chowkis, the Pink Booth and compound walls of other properties. Hence, the red light zones concentrate on one side of the road bordered by the kothas. The Pink Booth is an initiative that packages the police chowki in an informal institution to lodge women complaints without going to the police station. It also provides occupational training for sex-workers giving them skills and avenues for change.

The brothels along the road in GB Road are low-rise structures constructed in a row. The building is an 80-100 years old structure with very poor maintenance. The building has an open sewage pipe running along the building. There is a narrow staircase that starts from the ground floor and goes to the terrace. The width of the staircase is less than 750mm with no provision for light and ventilation making accessibility difficult. The first and the second floor have rooms on either side of the staircase with approximately 10-12 women and girls living in the brothel (Aksa Joy, GB Road and its intriguing architecture in Delhi). It also has Connaught Place-like corridors, Old Delhi-type havelis, and even an ATM, tucked right next to a Madame's kotha. It houses temples, a mosque and a school (Hindustan Times, 2009). On an urban level, the zoning of the functions of G.B.Road include programs that are necessarily not brothel specific. The shops linearly placed cater to a larger audience, hence inviting a mixed crowd to co-exist with prostituhơn in the urban setting, subconsciously diluting the stereotypes of the space during the day.

6. Spatial Review

The spaces shared between the stakeholders of the prostitution business and others (Other Businesses & Individuals) share an important aspect of space making. The concept of the moral space bubble is seen through the spatial analysis of these localities and areas and provides a look into their inner workings.

6.1 Kamathipura - The Play of Frontage

Dilapidated residential buildings form the brothel spaces of Kamathipura. The normal looking structures do not give an immediate identification of a brothel as those buildings are also occupied by normal families, however they perform no less than ones at Budhwar peth or G.B. Road. Most customers are picked up by the women themselves from the streets or mostly by the pimps. The streets are lined with women who would lure potential customers, and a few pimps talking with their regulars. Few pimps also operate as drug smugglers who interact with their customers in the open. The streets can be summed up as a combination of women, pimps and hawkers who are looking for their customer base, these streets also occupied by workers and Traders, moving around with their goods.

Figure 4: Typical Streets of Kamathipura
Source: Author

The streets form an important aspect of public display of The Business of prostitution and are essentially what is visible to the society as a whole. The public part of the business is played out on these streets lined with numerous customers from various walks of life who take part in the business of prostitution as consumers. They contribute an important aspect of not only bringing a due visibility of the industry, but also a visibility to the very horrors of Human trafficking and forced *'Dhandhewalis'* which are still very much prevalent today.

Within the stigmatised boundaries of the society of Mumbai, Mostly the private aspect of the business is well hidden within these dilapidated buildings, giving them an inherent invisibility. Due to the mixed nature of the area which not only facilitates to sex workers but also to an entire market & an industry of FMCG and their beneficiaries, they overlap and merge in its varied looks of specific streetscape of Kamathipura, making it almost homogenous in a way of identification.

Figure 5: Prostitute's Room, Kamathipura
Source: licensed photo by Natu N. from the Times of India: https://timesofindia.indiatimes.com/india/why-sex-workers-are-putting-their-health-and-safety-at-risk/articleshow/98475350.cms

6.1.1 Kamathipura - Dwelling in the interiors

Most of the Brothels are a single room apartment or a bigger apartment bifurcated down to each individual room being designated as the brothel. Each room is occupied by an individual sex worker and is the designated workplace for her throughout her life. Most of the rooms are dainty and small, just enough to accommodate one person. The room is fit with a small cottage and sometimes a small cabinet full of essentials. Many of these rooms don't even have windows or fenestrations and sometimes only a single light bulb that illuminates the room.

The Buildings are mostly dilapidated, under maintained and rusty without proper facilities of clean water or waste disposal which causes these buildings to accumulate waste in various interiors spaces. The walls are covered with paan spit and gutka, and all the rooms are extremely unhygienic. These spaces are shared by these women who spend their entire lives clocked to the same 4 walls that confine them in conditions, which to say the least, are extremely inhumanely kept.

6.2 Budhwar Peth: The play of Frontage

There are two major types of the brothels based on the construction material and age of the building. The major centre of the Red Light Area is a mix of both the types. The Hijra community occupy the wadas and are maintained. Rest of the wadas have got notice for redevelopment. They are very congested and are occupied by old prostitutes or left redundant. The RCC brothels are occupied by the young prostitutes. They cause less spill out over streets for soliciting and it takes place within the building corridors. Paan shops are positioned at the foot of almost every brothel. All the brothels are majorly mixed used in typology with retail shops. Pann shops, lottery shops, parlours, cafes are the prominent repeating space programs here.

Prostitutes from the wada occupy the streets for soliciting whereas in the building style brothels, they occupy lobbies and corridors. This style is a basic apartment that has been proposed as a brothel by adding partitions and mezzanines to make cabins. An average of eight to twenty-five prostitutes stay in a brothel. Hence, the footprint of the area is less than the equivalent of population. The end of the lane positions the Farashkhana Police Chowki. Street prostitution is prominent both during day as well as night leading to the ghettoization of the area where non-brothel activities are not aligned. With the majority of the brothels clustering together across the road and at prominent junctions, it does not get diluted as a part of the market, rather marks stark thresholds in spite of historic tourist attractions at the edges of the place.

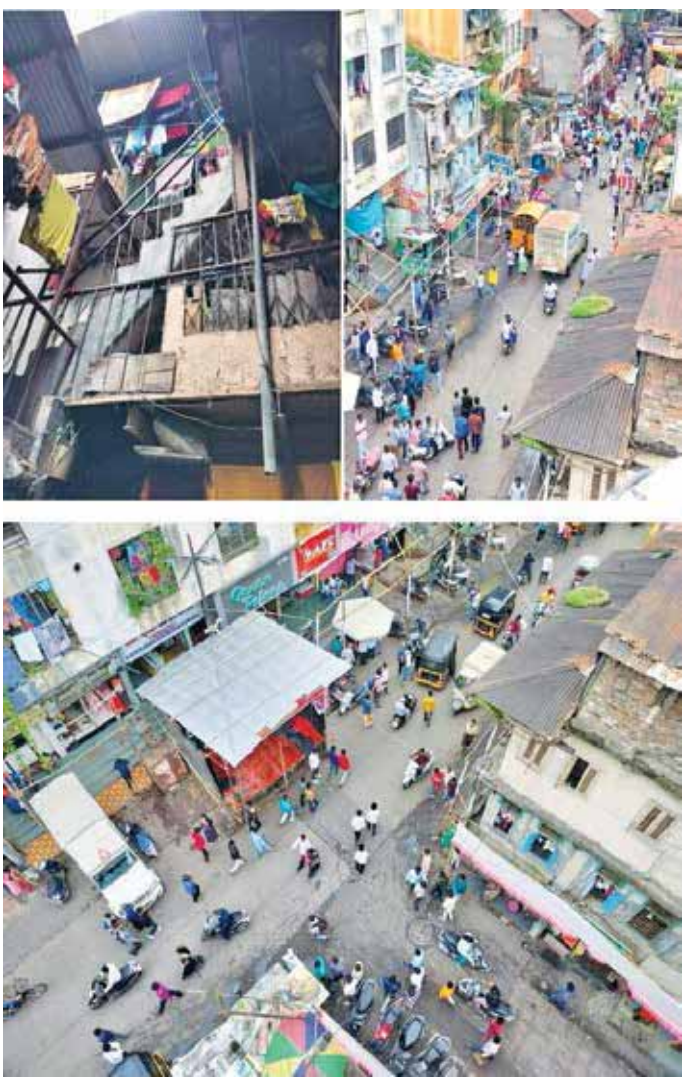

Figure 6: Streets of Budhwarpeth
Source: Author

6.2.1 Budhwar Peth: Dwelling in the interiors

The interiors of brothels in Budhwar Peth are as regular as any flat except for the partitioning done to utilise efficient space for cabins and business. There is lack of ventilation, low ceiling heights and the wadas show broken flooring and timber members at places. The cabins are tight where hardly one single bed can fit. Few wadas still retain decorated ceilings from the historic times, yet some leave traces of tunnels for escapes during raids. The FSI is majorly unutilized in the area in spite of having extremely high property rates. One of the major reasons for the ignored development of these structures is the pattern of ownership. Most of the kholis operate on rental typologies where neither of the parties contribute towards the renovation and maintenance of the space. As most women belong to agricultural backgrounds, they often set up planters within the brothels for part time recreation.

Figure 7: Typical Room of Prostitution in Budhwar Peth
Source: Author

6.3 G.B.Road : The play of Frontage

The scenes of the street of G.B.Road are pretty ordinary - shops, migrant labourers, rickshaws, cars, pull carts, bikes, bins, chaat-wallas, women in sarees and in burkhas. Also very prominently, the edges of the streets are occupied by cars for parking along the two-way road separated by a divider.

Above mechanics and automotive shops are dilapidated balconies, bright colours on the walls and once-upon-a-time pretty balconies with intricately designed balustrades or windows with wire mesh. Behind those windows and balconies, you will notice a line of clothes hanging out to dry and faces – brightly and garishly painted. Women and girls up on those balconies and windows stand huddled together (Delhi Dweller, 2024). The frontages of a commercial street are the ultimate measure of its marketing. In a generic adapted scenario, where a red light district is picturized dominantly over women soliciting on the streets, ordinary market activities become a shared identity in G.B.Road where soliciting happens through the windows and balconies from the vertical interfaces of the construction; again initiates coexistence and visual balance to an assumed imagery of the red light district. Brothels in G.B.Road mark an entirely separate world, where the entry is from the "kotha number" within the corridor, leading to a dark narrow staircase to the cramped interiors. Here the kothas are divided based on the category of the sex-workers, from Nepalis to the Bedia community of Rajasthan.

At an urban scale, the clustering of all brothels along only one edge of the road also dilutes its influence on the other activities of the street. The area has a more linear and organised street layout. It is a major arterial road, facilitating easier access but also leads to high traffic congestion.

Figure 8: Street Photograph of G.B. Road Delhi
Source: licensed photo by Delhi Dweller from the So City: https://so.city/delhi/article/gb-road-market-new-delhi

Figure 9: Aerial Street Photograph of G.B. Road Delhi
Source: licensed photo by Steffan Lindberg from the Aftonbladet: https://www.aftonbladet.se/nyheter/a/KVyk6/har-ar-gatan-dar-barn-valdtas--varenda-dag

6.3.1 G.B.Road : Dwelling in the interiors

An exposed sewage pipe runs the length of the structure. Starting on the ground level, a tiny stairway leads to the terrace. The stairway is narrow—less than 750 mm—and lacks lighting and ventilation, which makes it challenging to use. Additionally, the staircase's slope does not meet regulations. There is

an open floor layout inside. Beside the stair landing is the entry door. To the left, there's an open kitchen with an exposed drain next to it (Aksa Joy, GB Road and its intriguing architecture in Delhi). The interiors of the brothels, re-shaped with the partitions at times, have hidden taikhanas planned in the layout where hidden entry and exit points help transit trafficked minors or women to hide and escape from one kotha to the other at the time of a raid. They may be from under the bed, low height mezzanines, through in built almaris or pseudo cabinets (Pallabi Ghosh).

7. Results and Discussion

In terms of building typology, Kamathipura is characterised by predominantly low-rise, old, and dilapidated buildings, whereas Budhwar Peth features a mix of traditional and modern multi-story buildings. G.B. Road consists of multi-story, utilitarian buildings with commercial spaces on the ground floor. Space utilisation in Kamathipura involves overcrowded rooms and intensive use of space with a commercial and residential mix, similar to Budhwar Peth, which also has a strong commercial presence on the ground floor. G.B. Road has a linear layout with a clear distinction between ground-floor commercial spaces and upper-floor brothels. Public spaces and infrastructure are limited in all three areas, with Kamathipura and Budhwar Peth having poor sanitation and utilities, and G.B.Road are dominated by commercial activity and lack proper sanitation infrastructure. Architecturally, buildings in Kamathipura are in a state of neglect, reflecting the area's historical and socio-economic challenges, while Budhwar Peth presents a mix of old and new structures with varying states of maintenance. G.B. Road's buildings are functionally designed, prioritising utility over aesthetics or comfort.

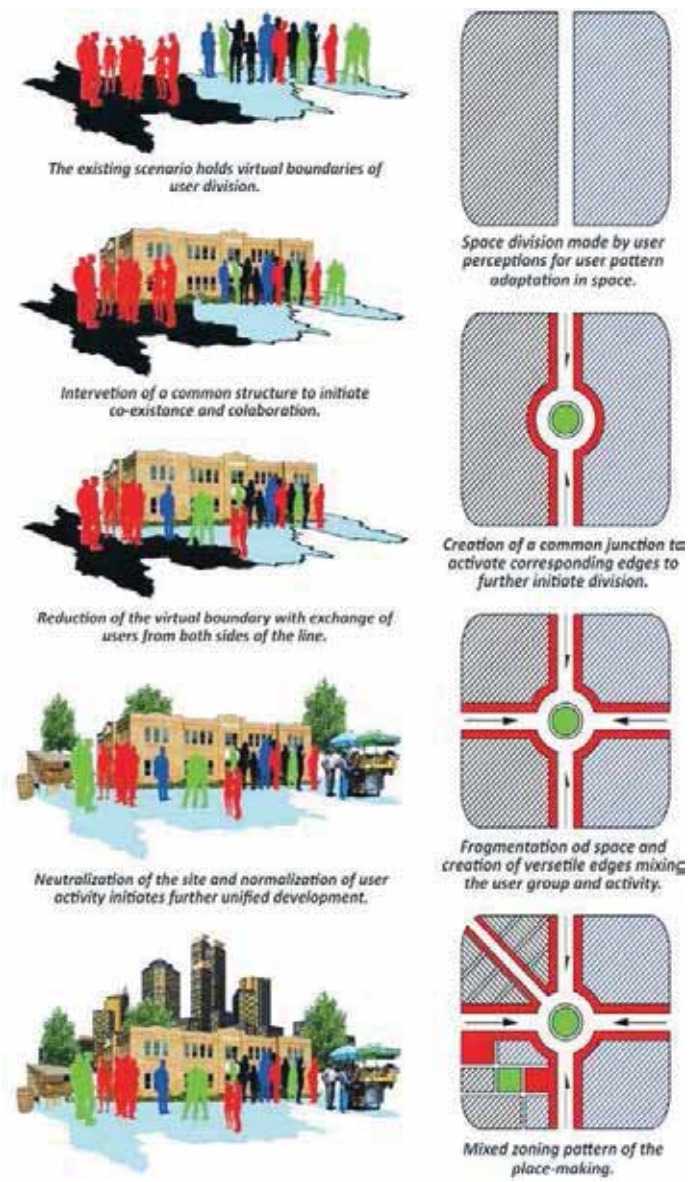

Figure 10: Prospective Proposal
Source: Author

While the Legal Framework regulating sex work is similar throughout the 3 locations, the Actual on location differences create their own unique way of governance, In Kamathipura, Mumbai we tend to see a tolerated zone of Moral Prostitution. Law enforcements usually tend to blind sight the brothels and carry out a few raids every once in a while. Most of the women in sex work in Kamathipura are trafficked throughout india and are indebted to their pimps, which leads them no other option but to be part of Prostitution in order to pay back their dues, a few women are also independent sex workers who just prefer to be in the business and tend to not have any pressure from any authority to be in the business. Kamathipura forms a mix of these women who all have their own individual stories that are unique who come together to form the landscape of *'tolerated moral prostitution'.* We see this especially in terms of the mixed use nature of the area, where everyone is the stakeholder, and everyone is there for their own purpose. Kamathipura houses them, shelters them and creates a 'pseudo safe space' for not only these women but also various other stakeholders to prosper in their own way. Similarly G.B.Road being an example of co-existence, it initiates from the margin of development yet getting stagnant at a point becoming a victim of stereotypes and unacceptance parallel to crime and poverty in these lanes. Budhwar Peth, unlike the other two districts, runs on the administration of prostitute and manager rather than prostitute and pimp, which makes them independent of their decision for growth and occupational shift. Many prostitutes here work part time and actively participate in festivities

and gatherings. Initiating programs for financial education, business aids and entrepreneurship can highly impact these women to repurpose a space like a brothel that remained stagnant with the need of time.

Ignored aspects of children where they find no corner but under the buds where the customer is using the space impacts drastically on their minds. Offspring of commercial sex workers are extremely susceptible to various types of risks. Since they don't have a separate place to live, they are exposed to the commercial sexual activities that take place around them as they grow up. Their morality and social values are impacted by being forced to live a life of deprivation, neglect, and abandonment. Medical Vans become a very common initiative to support the community. Still space design demands the variation in the power status of the stakeholders to function in the proposed programs for development. There are hardly any sex workers staying there as their occupation pulls them back to Budhwar Peth. This makes the Rehabilitation Homa a failed module as it also lacks to generate any profitable revenue. On the other hand, the community cleaning module by the PMC works successfully by creating a part-time income opportunity and diverting them from the materiality of prostitution. Hence, a part-time occupational shift can turn out to be an upliftment strategy.

8. Conclusion

The red-light districts of Kamathipura, Budhwar Peth, and G.B. Road, despite their unique contexts and histories, share common challenges of overcrowded and poorly maintained infrastructure, lack of public spaces, and inadequate sanitation and utilities. Their architectural and spatial characteristics are shaped by their socio-economic realities, making them urban heterotopias within the larger city fabric. Addressing these challenges requires a multi-faceted approach that includes urban planning, community involvement, and policy reforms aimed at improving living conditions and social inclusion for the residents of these districts. Effective community development often involves collaboration and communication among these various stakeholders to address the diverse needs of the community. Yet, prostitutes hold the identity of the space and stand out as primary users. Although, deeply understanding the occupation is necessary for proposing any intervention. The occupation is pretty temporary in correspondence to the age of the prostitute. This affects their routine and everyday economics. The earning of a prostitute is a daily basis money-in-hand module that is informal and irregular in terms of the amount.

The existing master plan depicts a cluster of brothels that in reflexes congest the prostitutes and their customers making it visible and visually prominent and chaotic. Fragmenting this cluster can dilute the chaotic impact and increase the edges of assertive activation. The clan can be deconstructed and treated individually to eliminate the larger heterotopia. The next step initiates towards the neutralisation of the zoning and user activity. This introduces the aspect of urban acupuncture. The acupuncture puts forward a common ground for the user group to start homogenising and increase the limit of approach, interaction and acceptance. This shall initiate the transformation of the identity of the place. Dilution and concentration shifts of certain functions help in the neutralisation at a social level, being able to solve practical issues of the market.

The construction industry requires a substantial labour force, frequently leading to significant migration. This influx of workers often results in an increased demand for local services, including brothel services. Similarly, prisoners, who have limited interaction with females, often exhibit cases of homosexuality. In occupations such as truck driving or military service, where individuals may be away from their spouses for extended periods, there is a tendency for increased engagement with sex work services. Therefore, prostitution is a contemporary necessity that calls for the design of spaces specifically for its inclusion in urban planning.

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Interviews

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ARTICLE

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Advancing Architectural History Education in India

The Role of 3D Photogrammetry in Enhancing Pedagogical Practices

By Maniyarasan Rajendran and Athira TP

1. Introduction

Architectural education at Indian universities is designed to equip students with a broad and deep understanding of architecture, integrating both theoretical insights and practical skills. The curriculum typically includes a blend of foundational courses, core subjects, and specialised electives, aimed at developing a holistic perspective on architectural design, technology and practice. The students are introduced to various aspects of architecture, from basic design principles and visual communication to advanced topics in building technology, environmental systems and digital tools.

Architectural History is a major core component within the humanities modules at most architecture schools, either covered in one semester or spread across two or more semesters. At the undergraduate level, the curriculum begins with a global perspective on architectural evolution, categorised by regional timelines and ancient civilisations. The course adopts a holistic and comprehensive approach, analysing various aspects of world architecture. Before delving into the specific architectural styles and building types, the syllabus generally suggests discussing foundational features such as the geography of building materials and resources, construction methods, and the sociological background, including the influence of religious, political and economic classes (SPA Bhopal, 2016; SPA Delhi, 2016). It also highlights the influential architects who have contributed to the establishment of distinct architectural styles and features. Thus, the curriculum enables the student to understand how architecture has been influenced by society and culture through the ages.

Additionally, Indian architecture is also studied as an integral part of the curriculum. The syllabus covers Indian architectural styles from the Vedic era to the nineteenth century taking into account India's extensive interactions with other regions and offering students analytical tools to understand the historical evolution of design and construction techniques (SPA Delhi, 2016). A comparative study of the different stages of development in India and other parts of the world will link it to the socio-cultural, political, religious and climatic factors of each region. The course also examines the human activities in modern history that impacted arts, science, modernism, colonialism and other technological developments, specifically in the twentieth century (CEPT University, 2013).

Upon completion of the course, students should be able to identify and distinguish various historic architectural styles and recognise significant historic buildings by their design components and styles. They will be adept at describing notable historic buildings and analysing the socio-cultural, political, religious and climatic factors that influenced the development of different architectural styles. This

foundational knowledge helps students understand the development of space and structural quality in design, enabling them to envision architecture that is responsive to contemporary societal needs and reflects current philosophies and create smaller structures with applicable principles and innovative use of conventional materials, inspired by historic buildings (SPA Delhi, 2016).

1.1 Aim and Objectives

This paper aims to examine the use of 3D photogrammetry technique in advancing the pedagogy surrounding architectural education in India, with focus on the architectural history course. It explores the benefit of using this technique over the existing method of teaching architectural history. It examines the extent of information photogrammetry can provide, such as the architectural elements, structural systems, construction techniques, details, ornamentation, iconography, etc., and the various applications of its outputs to aid education in history, architecture and conservation. It will further explore how virtual reality models and printed 3D models can enable this process and assess the future potential of photogrammetry in architectural education.

2. Literature Review

Although the course is intended to spark curiosity and sharpen observational skills among the students by exploring concepts of culture, time and space through historic architecture, the course design has a lot of limitations. In India, the current pedagogy predominantly relies on textbook studies, analytical exercises, sketching and model-making and occasionally, field trips, subject to the available resources of the institution.

Architecture students frequently face an excessive burden as all their core subjects, particularly studio projects and practical assignments require the same amount of attention, time and labour. Thus, theoretical courses like Architectural History fail to hold students' attention. Often the students end up memorising a lot of factual material which contributes to a lack of engagement. Due to factors like time constraints, preconceived beliefs and a lack of underlying knowledge, effective teaching is hampered, and interaction between students and teachers is restricted. As a result, instead of being active participants, they become passive recipients (Dave, Parikh; & Baghel, 2018).

There is a need for shifting towards a student-oriented learning approach from a knowledge-teaching approach by the professors, with focus on an imaginative and multi-participative methodology (Cimadomo, 2014). According to Hudnut, for pupils to form a solid mental image of structures, they must first encounter them conceptually or through a holistic conception of them (Hudnut, 1957). In this context, sketching exercises and model-making effectively etch the design concepts and elements in the students' minds more deeply than traditional lectures. Physical models, in particular, enable the student to have an enhanced understanding of structures, develop spatial awareness, promote attention to detail and improve visualisation skills, resulting in a tactile learning experience.

Additionally, field tours and travel-based pedagogy is pivotal in architecture education as it has a significant exposure to experiences beyond the classroom (Qadir & Kamal, 2022). It exposes students to diverse architectural styles and historical periods, enhancing their understanding of scale, proportion, and spatial dynamics. Immersing in different cultures helps students see how local customs influence architectural practices, fostering cultural awareness essential for relevant design. Observing real-world architectural solutions provides practical lessons, while new environments inspire creativity and innovative ideas.

Architectural pedagogy involving audio-visuals along with lectures have been proven to be more effective than traditional Power Point presentations in the past (Dave, Parikh, & Baghel, 2018). In this ever-changing setting, the teacher's role shifts from merely delivering information to guiding students in understanding and visualising concepts of form, colour and light (Hudnut, 1957). This approach keeps students at the heart of the learning experience, enabling them to gain significant educational advantages through interactive knowledge transfer methods (Hicks, 2011).

With the rapidly growing technology, it is imminent to make use of these for education purposes. Photography as a discipline plays various roles in architectural history, including depicting, describing, and identifying structures, as well as representing notions of dialectic and temporality (Borden, 2007). It can be further used for documentation and knowledge-dissemination purposes, such as 3D photogrammetry which has a variety of applications in the cultural sector.

3. 3D Photogrammetry as A Pedagogy Tool

Photogrammetry is the science of obtaining reliable information about the properties of surfaces and objects without physical contact with the objects, and of measuring and interpreting this information

(Schenk, 2005). Photogrammetric documentation captures high-resolution photographs of a heritage asset from various angles in a sequential manner with significant overlap. This method allows for obtaining metric information from the photos to create 3D reconstructions of the object. The method is user-friendly and reduces the workload for fieldwork. It requires minimal equipment and is a cost-effective and time-efficient alternative to traditional methods of documentation. The general workflow of a photogrammetry project begins with careful planning which includes defining the project's scope, figuring out the level of precision needed and choosing the right equipment (Historic England, 2017). For an accurate reconstruction of the 3D model, it is necessary to identify important elements in the study area that can be used as control points. The acquisition of photos is crucial, as the accuracy of the final model is directly impacted by the quality and coverage of the photographs. It is essential to select a suitable flight or imaging strategy, taking into account factors like overlap and ground resolution. Pre-processing then corrects distortions, removes outliers and improves the quality of the dataset as a whole. It is essential to handle metadata properly, including processing and accuracy reports. For additional analysis, the cleaned photos are put into photogrammetric software. By calculating the interior and exterior orientation of the images and finding the common points, the Structure from Motion (SfM) technique helps to generate a sparse point cloud. Accurate geo-referencing is ensured by optimising point cloud alignment with control data. Then, by projecting pixel data as three-dimensional points, Multi-View Stereo (MVS) processing creates a dense point cloud. High-resolution meshes, textured models, tiled models, orthomosaics and digital elevation models (DEMs) are among the final outputs that offer useful data for a range of applications. For further processing and analysis, photogrammetry outputs are frequently incorporated into other software applications like CAD or GIS. This allows for applications in topography analysis, infrastructure design and urban planning. The last phases include preserving the data for future use and sharing the findings with stakeholders via interactive models, reports or visualisations.

Photogrammetry stands out from other documentation techniques such as laser scanning due to its ease of use and cost-efficiency. However, the use of photogrammetry for documenting built heritage in conservation practice has only recently emerged. While the use of photogrammetry in architectural education is still rare in Indian institutions, it has been more adopted in institutions in other countries. Here, we examine the application of photogrammetry in student and audience engagement through various case studies.

3.1 Case I: 'Harir-e-Live', a Virtual Performance at Bai Harir ni Vav Stepwell, Ahmedabad

The project was a collaborative site-specific exploration of the Bai Harir ni Vav Stepwell in Ahmedabad with ASI Vadodara Circle in 2022 (figure 1). The study examines the connection between Indian architecture and classical dance by using the digital conservation tool of photogrammetry to facilitate the need for interdisciplinary conservation strategies, addressing public engagement and structural conservation. The research proposed simulation-based experimentation to evoke fantasy and abstraction, combining digital tools with choreography to foster visitor engagement. This research project was conceived upon recognising that digital mapping of heritage sites serves not only as a crucial tool for conserving architectural structures but also as a means to construct virtual environments.

Figure 1: Orthomosaic generated through photogrammetry of Bai Harir ni Vav Stepwell, Ahmedabad
Source: Authors

The photo-scanning of the stepped well was undertaken by the authors for two days with a total of 1800 photographs captured of the stepped well (including its five levels and the ground level). It was then processed in Agisoft Metashape Professional, creating dense point cloud files with mesh and textures. Using a tripod helped negate the varying light and shade conditions through the stepped well. With Metashape point cloud files as base, platforms such as Unity and Blender were used to create a 3D model of the site. After compiling all available data and creating a 3D model of the site in Unity, a week was spent in the motion capture TrakLab at the University of Melbourne. After a few days of setting up the virtual environment alongside the physical setup of the motion capture studio, a sequence of camera positions was choreographed, responding to the architecture visible in the frame. The product of this exploration was a performance in the TrakLab to an invited audience composed of students and

staff of the Victorian College of Arts, who watched the live movements. One could witness the creative interpretation of the site's architecture, created using photogrammetry, through the virtual performance on the screen. The digital representations generated offer a unique platform for experimentation and creative exploration, providing opportunities beyond those possible within the physical realm. The performance in the virtual site was screen captured as a method of documentation for future dissemination to an audience beyond those present in the studio.

The project demonstrates the crucial role of photogrammetry in digitising and preserving cultural heritage, allowing global audiences to explore historical structures through virtual tours, interactive exhibits and online resources. When direct contact was not possible, the virtual space effectively facilitated a holistic sensory experience. By creating accurate digital representations, it provides detailed insights into architectural heritage, serving as valuable educational tools for academic purposes.

3.2 Case II: CyArk's Virtual Reality Experiences and Lesson Plans for Education

CyArk, founded in 2003, is an organisation dedicated to preserving and celebrating cultural heritage using 3D recording technologies, creating immersive experiences to engage new audiences. They offer virtual tours and educational lesson plans for their projects, aimed at school students. For the digital preservation project of Rani ki Vav in Gujarat, CyArk's lesson plans focus on teaching students about the construction techniques of stepwells using a 3D photogrammetry model (figure 2). The students are encouraged to explore various aspects of the stepwell through prompts, such as construction features, access points, original water sources, materials, tools used for ornamentation, the impact of water on construction materials and the connection between the stepwell's functionality and spirituality, along with other similar sites in the area. Following this exploration, students complete an assignment to build a scaled model of the stepwell, beginning with a sketch that can be hand-drawn or created using AutoCAD. These lesson plans provide a comprehensive understanding of water heritage in the western part of India. However, a limitation of the project is the low quality of the 3D model displayed on the website, which, despite accurately depicting the scale and form, lacks detailed texture. Only selected parts of the stepwell are depicted with high accuracy. Improved accuracy is needed for effective educational purposes.

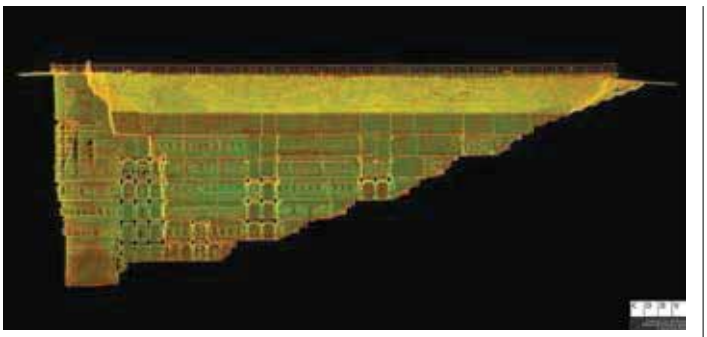

Figure 2: 3D point cloud of Rani ki Vav Stepwell
Source: CyArk & Centre for Digital Documentation and Visualisation (CDDV)

Similarly, for Rosslyn Chapel in Scotland, lesson plans are divided into three segments – understanding Gothic architecture, the documentation process, and the engineering aspects of arch designs. While they do not offer a 3D model for viewing, the panoramic virtual tours provided are informative. However, the absence of a 3D model is a notable drawback.

3.3 Case III: Digital Approaches for Heritage at Risk

Digital documentation techniques are crucial for preserving endangered heritage. This is evident in the case of the Notre Dame de Paris Cathedral, which suffered extensive damage to its roof and spire in a fire in 2019. Art Graphique & Patrimoine (AGP) has been performing 3D laser scans of the cathedral since 2010, which proved invaluable for its reconstruction. AGP has utilised advanced laser scanning technologies, including lasergrammetry and photogrammetry, to conduct multiple detailed 3D surveys of the cathedral's interior (figure 3). Post-fire surveys provided vital data on the structure's dimensions and the impacts of the collapses. AGP's long-term digital surveys, spanning around two decades before the fire, were invaluable. They also supported the Public Establishment for the Conservation and Restoration of Notre Dame and the CNRS in creating a "digital twin" of the cathedral. When extensive damage befalls a historic structure, it presents a unique opportunity to either

Figure 3: BIM model of Notre-Dame de Paris Cathedral
Source: Art Graphique & Patrimoine

restore it to its original state or introduce subtle design modifications. In this scenario, the use of digital twins and Heritage Building Information Modeling (Heritage-BIM) becomes essential. These technologies provide a detailed 3D model that serves as a foundational tool for design projects within historic contexts. By leveraging these digital models, architects and conservationists can enhance the design process, gaining a deeper understanding of the challenges and intricacies involved in preserving and adapting historic environments. This approach not only facilitates precise restoration but also allows for thoughtful integration of modern design elements, ensuring the heritage site's integrity and relevance are maintained.

Similarly, digitisation initiatives for heritage structures facing demolition are pivotal in preserving public memory and fostering community engagement. For instance, Xequalto's photogrammetry digitisation of Ashoka Hospital in Calicut, conducted under their *Digital Archive Project*, allowed for virtual reality walk-throughs even months after the government demolished the building. This effort not only safeguarded the hospital's historical significance but also provided a virtual platform for the community to experience and remember the structure long after its physical presence was gone.

3.4 Case IV: Augmented Reality using a Simple Google Search

Google's 3D and augmented reality (AR) experiences, accessible through its search function, offer an innovative way to explore cultural heritage sites and objects. Although currently limited to a few select sites, this feature is easily accessible to anyone with internet access, allowing for remote viewing and engagement (figure 4). The key advantage of this tool is its accessibility, enabling students, educators and the public to explore cultural heritage sites from anywhere. This democratises education and enhances architectural history lessons by providing dynamic and interactive 3D models. Integrating Google's AR capabilities into architectural history education can significantly enrich curricula without requiring specialised equipment or extensive resources. This fosters a deeper appreciation for cultural heritage and inspires further exploration of digital documentation techniques.

3.5 Case V: Digital Technology Labs at Educational Institutions

Several universities around the world have established advanced digital labs that focus on creating immersive experiences, significantly enhancing the educational

Figure 4: Google's AR experiences for Gateway of India in Mumbai and Brandenburg Gate in Germany
Source: Google

landscape for their students. For example, the Harvard University CAMLab (China Art Media Lab) integrates technology with art and cultural heritage to produce virtual reality experiences that allow students to engage with historical artefacts and environments interactively. This lab not only provides students with hands-on experience in digital preservation and storytelling but also fosters interdisciplinary collaboration, bridging the gap between technology, art, and history.

The University of York's Centre for Digital Heritage uses 3D scanning and VR to enable students to virtually explore archaeological sites, enhancing their understanding of historical contexts. Similarly, the Digital Heritage Research Laboratory at the Cyprus Institute of Technology is another exemplary setup that benefits students immensely. Students at this institution have the opportunity to participate in cutting-edge research and projects that often receive international recognition.

Having access to such advanced lab setups has proven to be highly beneficial for students, providing them with unique learning opportunities and practical skills. These experiences of real-world projects and collaborating with experts not only enhance their academic and professional profiles (Shults, 2019), but also contribute to the institutions' reputations in the field of digital heritage and virtual reality.

4. Data Analysis and Findings

Based on the case studies, the application of digital documentation techniques like photogrammetry in architectural history education can greatly enhance student learning. The first case of Harir ni Vav Stepwell shows how virtual experiences created through photogrammetry enable students to explore architectural spaces remotely, providing a comprehensive sensory experience. The second case of CyArk projects highlights the importance of high-quality 3D models and effective lesson plan formats. Well-designed lesson plans, based on accurate digital models, improve students' comprehension of historic structures, while poor-quality models and inadequate plans can limit educational value. The

third case on endangered heritage showcases the role of digital tools, such as Heritage-BIM (HBIM) and digital twins, in aiding design development in studio projects that deal with historic environments. It also highlights the need for digital archives that can be utilised for architectural history education. The fourth case of Google's 3D and augmented reality experiences demonstrates the need for easily accessible and dynamic tools for enhancing architectural history education and broadening access to cultural heritage sites. The last example of overseas educational institutions emphasises the necessity of cutting-edge tech laboratories in educational institutions.

4.1 Benefits of using 3D Photogrammetry in Architectural History Education

The use of 3D photogrammetry in architectural history education offers numerous benefits that significantly enhance the learning experience for the students. One of the primary advantages is the improvement in student engagement and interaction with historical sites and artefacts (Baik & Alitany, 2018). By providing a more tactile experience similar to physical models, the 3D printed model generated from photogrammetry allows students to explore and analyse architectural details in a hands-on and accurate manner.

Photogrammetry also facilitates interdisciplinary learning opportunities by promoting collaboration between architecture, history, technology and other disciplines. The integration of these fields enhances the overall educational experience, providing students with a comprehensive understanding of architectural history. Detailed 3D models offer enhanced visualisation and understanding of the architectural vocabulary and complex concepts, making it easier for students to grasp intricate architectural and historical details (Kowalski, Samól, Szczepański, & Dłubakowski, 2020).

Extended Reality and immersive tools created with photogrammetry provide a sensory-rich experience that closely mimics real-life interactions. This interactive approach leads to greater retention and understanding of the subject matter as students can visualise and manipulate 3D models to gain a deeper comprehension of architectural structures and their historical contexts. Interactive learning experiences engage students more deeply, encouraging active participation and exploration which leads to improved spatial awareness and critical thinking skills.

In terms of accessibility and preservation, 3D photogrammetry makes historical sites accessible to students remotely (Paladini et al., 2019). Especially during pandemic-like circumstances and when the sites are far away from the architecture schools making it not feasible to travel, it becomes an alternative to physical travel and broadens the range of educational opportunities.

Additionally, 3D photogrammetry allows for the customisation of learning materials to cater to diverse learning styles and educational needs. By providing a more inclusive educational environment, students can learn in the way that suits them best, whether through visual, tactile, or interactive methods. This personalised approach to education ensures that all students have the opportunity to succeed and thrive in their studies.

Furthermore, digital preservation of architectural heritage ensures that detailed records of historical sites and structures are maintained for future generations and can act as a base for future advancements in virtual reality and other applications. This technology protects against decay and damage, preserving valuable cultural and historical information.

Overall, the integration of 3D photogrammetry in architectural history education enriches the educational process by enhancing engagement, accessibility, preservation, interdisciplinary collaboration and personalised learning. This technology opens up new avenues for a comprehensive and interactive understanding of architectural history, ultimately leading to a better-rounded and informed educational experience.

4.2 Challenges and Limitations of using 3D photogrammetry in Architectural History Education

Implementing 3D photogrammetry in architectural history education presents several technical challenges. Addressing these challenges is essential for maximising the potential of this innovative technology in the educational landscape.

For educational institutions that are not equipped with the required software and hardware, it can be challenging to set up. The cost and resource implications can be significant, as high-quality digital cameras, powerful computers, specialised software, and virtual reality headsets are often necessary. This can strain the budgets of educational institutions, particularly those with limited funding. However, it must be noted that this is an initial investment and the benefits after setting up can be innumerable.

Another major challenge is the need for training and skill development for educators as photogrammetry is a recently emerging technology. Teachers must become proficient in using photogrammetry tools and integrating them effectively into their lessons. This requires time and investment in professional development which can be a barrier to widespread adoption.

Accessibility and inclusivity issues also arise with the use of 3D photogrammetry. Not all students have equal access to the necessary technology such as high-speed internet and capable devices, creating a digital divide. Ensuring that all students can benefit from these tools is a significant hurdle.

Cultural and institutional barriers further complicate the implementation of 3D photogrammetry. There can be resistance to adopting new technologies, especially in institutions with long-established teaching methods and curricula. Integrating photogrammetry within existing curriculum frameworks requires careful planning and adaptation, which can be met with reluctance from educators who are accustomed to traditional approaches.

5. Recommendations

There is a need for advanced digital and tech labs at universities in the country, to support the integration of cutting-edge technologies in architectural education. Central institutions, such as the IITs and NITs, which have a strong focus on technology and innovation, can play a pivotal role in enabling this transformation. By leveraging their expertise and resources, the institutions can establish state-of-the- art digital labs equipped with the latest tools and technologies, including photogrammetry, virtual reality (VR) and augmented reality (AR). These labs would provide a robust infrastructure for students and faculty to engage in innovative research and practical applications, fostering a deeper understanding of architectural history and conservation. It is acknowledged that not all architecture schools possess the facilities or infrastructure required to conduct photogrammetry and develop virtual engagements. To address this limitation, a national digital repository of historic buildings could be established to enhance architectural history education across the country. This repository could be developed by central government institutions, public sector organisations or individual collectives involved in heritage documentation and conservation. Additionally, leveraging existing platforms like Google and Meta, which already offer augmented reality (AR) applications in engaging formats, could further expand access to a wider repository of cultural sites. This dual approach, establishing a dedicated national repository and utilising popular AR platforms, would significantly enhance the teaching and learning of architectural history, providing students with innovative tools to explore and appreciate historic structures.

Furthermore, faculty development programs are essential in this context. Organising workshops to equip educators with the necessary skills to effectively use photogrammetry and understand its potential applications is crucial. Additionally, fostering collaborative approaches between universities and tech- based organisations specialising in photogrammetry and extended reality can be considered as an alternative solution to bridge the gap in resources and expertise. Such partnerships can facilitate the sharing of knowledge, tools and best practices, thereby enhancing the overall quality of education.

There is also a need for planning out proper lesson plans that involve the utilisation of photogrammetry and extended reality experiences within the architectural history curriculum. Carefully designed lesson plans can ensure that these technologies are effectively integrated into the curriculum, providing a structured and comprehensive learning experience.

While 3D immersive experiences have their advantages, the use of handmade or 3D-printed models should not be overlooked. These physical models can complement virtual experiences, offering tactile and spatial insights that digital models alone cannot provide. Incorporating both virtual and physical models into the curriculum would offer a well-rounded educational experience, allowing students to engage with architectural history in multiple ways.

6. Conclusion

The study highlights the necessity of integrating photogrammetry and utilising its outputs, such as 3D- printed models and immersive experiences, into architectural history education. These methods enhance student engagement, sensory experiences, site accessibility, spatial awareness and critical thinking. The case studies underscore the significance of immersive experiences, well-structured lesson plans, the application of HBIM and digital twins, accessible VR/AR tools, digital archives and advanced laboratory facilities. The study recommends the creation of digital repositories of cultural heritage to serve as educational tools for universities and advocates for collaborative efforts

among universities, technology companies and individual collectives.

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Athira TP is an architect and built heritage conservationist with a strong interest in the integration of digital technologies in conservation practice. She has worked with various governmental, non-governmental and private organisations in the heritage sector of India. Currently, she is pursuing an MSc Digital Heritage at the University of York, UK.
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Teachers' Home

By Ar. Rohit Palakkal

Fact File

Project Name - Teachers Home

Location - Thalassery, Kerala

Plot Area - 8 cents

Built-up area - 2800 sft

Construction Cost - Rs 3500 per sft

Year of Completion - 2025

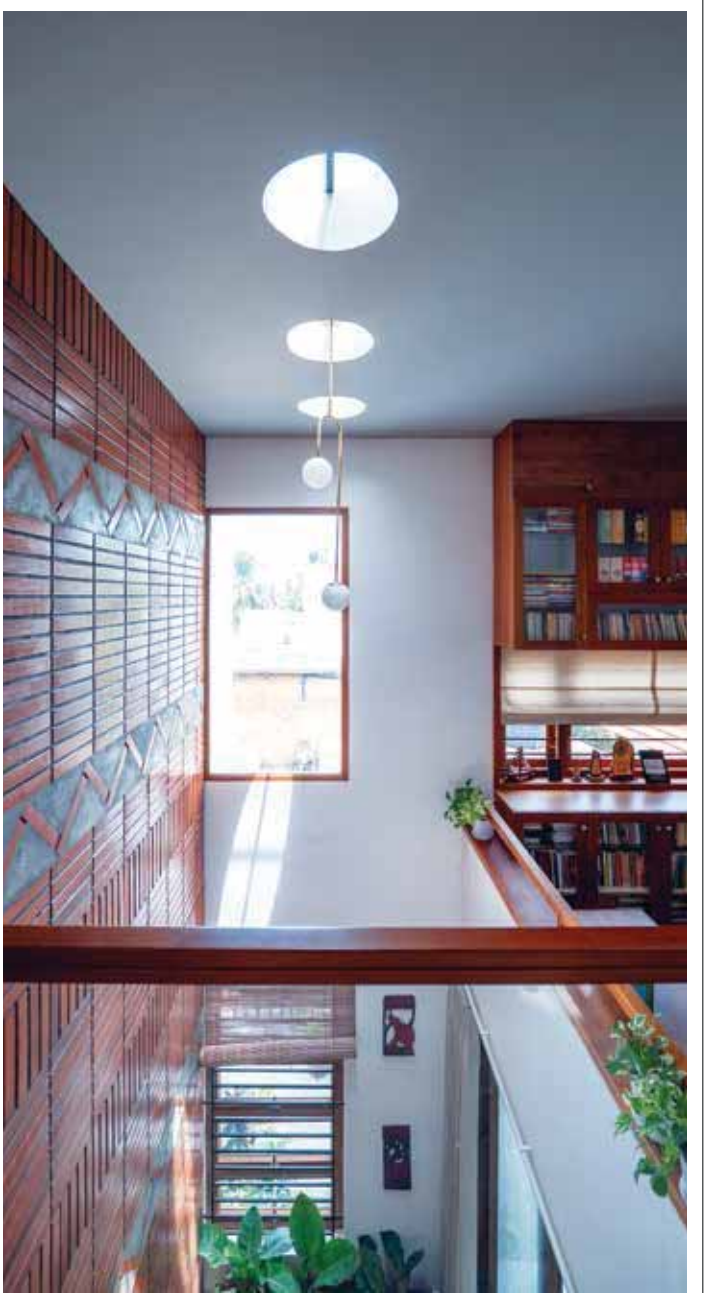
Architectural Design - Nestcraft Architecture

Landscaping, MEP, Structural Design - Nestcraft Architecture

Project Team - Ar. Rohit Palakkal, Er Niveditha, Er Asif, Er Deepika.

As architects, we were assigned to justify the right of a client — a teacher couple — to have designated spaces for their self-nourishment: mental, psychological, and emotional so that their wellness may illuminate the lives of countless students and future generations. For a residence owned by teachers, the architecture should reflect their values — practicality, learning, hobbies, creativity, and calm. Teachers are not merely deliverers of knowledge; they are motivators, guides, mentors, and emotional anchors in the classroom and society. Their psychology is grounded in caring, cognition, and commitment. A teacher's mental and emotional world is shaped by a passion for helping others learn, and the daily psychological work they do is both deeply demanding and profoundly meaningful.

We imagined the teachers' home to balance simplicity with meaning. Thus, the spaces are designed as open, filled with natural light and intellectually stimulating. We have tried to identify multiple informal reading nooks and garden pockets as reading and gardening are the hobbies of the family. Bricks, stone and wood are used to reflect authenticity and warmth. A compact front porch and garden with benches are



Double heighted spaces adds visual volume to the inner space
Source: Author

The front sit-out which acts as an indoor outdoor space
Source: Author

The gradual transition of the outdoors to the indoors
Source: Author

Main entry to the home
Source: Author

The sit-out
Source: Author

East elevation of the house
Source: Author

The space beneath the staircase landing is used as a patio adjoining the internal courtyard, visually expanding the spatial volume.
Source: Author

The stair mid-landing serves as a library overlooking the double-height courtyard with a skylight.
Source: Author

Play of natural light in the common areas.
Source: Author

introduced where there is a sit-out which encourages interaction with the visitors. The sit-out acts as an indoor-outdoor transitional space which can be used for small group tutoring, book clubs and also as the family gathering space in the ground floor. The living room, the dining room and the courtyard are double-height spatial volumes with skylights providing natural light in an ever-changing pattern throughout the day.

Ground and first floor plans
Source: Author

The heart of the home is a dedicated study space cum library with bookshelves filled with educational texts and personal favourites. This space is in the staircase mid-landing, overlooking the inner courtyard of the home. An open-plan, inviting dining area for discussions with fellow educators or students opens up to the kitchen through a breakfast counter which can be used for quick meals and snacking. The inner courtyard which is double-height with a skylight above conceives a minimal prayer space and planter pots open to a patio with a garden where one can read, write or tutor students informally. This space is accessed through a sliding window through the inner courtyard. This offers space to breathe and grow since the teachers need freedom to innovate, try new methods and continue learning. A house for a teacher is meaningful when it provides not just a space to live and work but a safe, welcoming and empowering space where teachers can live out their purpose, grow in their profession and feel at home every single day. The architecture introduced here reflects the soul of the teacher owners and places to nurture others, reflect, learn and grow.

Rohit Palakkal (A19849), founder of Nestcraft Architecture in Calicut, is a Mumbai University graduate (2009) whose design philosophy emphasizes low carbon footprint, natural materials and passive strategies. Centering light as a core design element, he creates context-responsive, sustainable spaces while actively teaching design and conducting workshops across architecture schools since 2010.
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More is Mess

A Visual Journey through Sacred Horses

By Vivek Sholai Raja

From my childhood memories, most of my vacations were spent in my grandparents' villages — Puduvalasai and Kalkurichi, both located in the southern part of Tamil Nadu. As I grew older, I moved to different cities to study and practice architecture.

Life in the city is fast-paced and filled with constant activity. This is reflected in contemporary architecture — more materials, colours, details, styles but less life. Even the places we go to for worship are becoming grand, highly detailed and overwhelming, losing their sense of intimacy and quiet presence. Instead of offering peace, these spaces are now becoming symbols of pride, power and wealth. The clarity of silence, openness of space and spiritual depth are often buried beneath this visual noise.

Drawing from my childhood memories, I created these sketches using different mediums to express the essence of those sacred village spaces — a few terracotta horses, some ritual weapons and open grounds where people gather to celebrate and worship. These places are not cluttered — they are generous in space and spirit.

This work symbolizes how a minimalist lifestyle can lead to a more meaningful and sustainable form of existence — one that cherishes essence over excess and allows life, architecture and faith to return to their purest form.

A morning walk through stillness (medium: digital sketch)

Moonlight and silence (medium: water colour, pen and ink)

Fire lights the night (medium: digital sketch)

Fire lights the night (medium: digital sketch)

Horses of Faith (medium: water colour, pen and ink)

Guardian in clay (medium: poster colour, pen and ink)

Guardian in clay (medium: poster colour, pen and ink)

Vivek Sholai Raja (A24968), is an award-winning architect who studied at Md. Sathak School of Architecture, Ramanathapuram. He has worked internationally on landmark projects such as the Burj Al Arab extension and the Museum of the Future. His current work focuses on rural and community-based design, creating climate- and people-centric spaces that merge regional building practices with contemporary strategies.
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IIA - UIA Agreement

The Agreement towards hosting of the *UIA International Forum 2027*, at Mumbai, India in the year 2027, was signed on 30 September 2025, coinciding with the auspicious occasion of *Durga Ashtami,* by IIA President, Ar. Vilas Avachat on behalf of The Indian Institute of Architects, in the presence of the IIA Vice President, Ar. Jitendra Mehta.

According to this Agreement, the first instalment of € 80,000 towards the 'compensation for the rights accorded for the organisation of the Event' has been paid to The International Union of Architects (UIA).

NEWSLETTER SEPTEMBER

CONDOLENCES

Ar. Subhash Bharsakale

16 November 1955 - 4 October 2025

IIA Amravati Sub-Center's sitting Chairman Ar. Subhash Bharsakale (A07537) left this world for heavenly abode on 4 October 2025. Born on 16 November 1955, he graduated from Visvesvaraya Regional College of Engineering, Nagpur. He practised as an architect and as a builder in Amravati. With over 45 years of rich experience, he pioneered the concept of apartment housing in Amravati, under his company Niwara Builders Pvt. Ltd. He was honoured for his diverse ranging work with the *43rd Engineers' Award* as well as the *Panjabrao Deshmukh Urban Co-operative Bank Ltd. Valuer's Award*.

He is survived by his wife and a son and a daughter, who are following their father's footsteps as an architect and a civil engineer respectively. IIA Amravati has lost a friendly soul, who will be missed dearly for his smile and gentle demeanour.

IIA HIMACHAL PRADESH CHAPTER

₹8.5 lakhs relief to Thunag disaster victims and free design services

Architects of Himachal Pradesh have come forward to support the families affected by the recent disaster in Thunag region. The IIA Himachal Pradesh Chapter has contributed a total of ₹ 8.5 lakhs as relief assistance for the affected families.

Under the leadership of Vastukar Nand Lal Chandel, Chairman IIA HP Chapter, a team of architects visited the Seraj region twice. During the first visit, the team assessed the damage caused by the disaster. On the second visit, they distributed the relief amount of ₹ 8.5 lakhs among 56 needy families.

Along with this financial aid, IIA HP Chapter has also announced free architectural services for designing houses for the homeless, ensuring safe and sustainable reconstruction. Additionally, architects will also provide free services for the planning and designing of community shelters in the affected region.

Architects of IIA HP Chapter with people of Seraj Valley who were given financial support

Ar. N. L. Chandel with his IIA HP Chapter Team, meeting former Chief Minister Shri Jai Ram Thakur, during the visit to Seraj Mandi.

The affected families have expressed their heartfelt gratitude to all architects of Himachal Pradesh for this generous and humanitarian support.

We believe that disaster-hit families need not only financial help but also technical and professional support to rebuild safe and durable homes. IIA Himachal Chapter will continue to extend its assistance in all such humanitarian causes in the future as well.

Vastukar Nand Lal Chandel, Chairman IIA HP Chapter

IIA MAHARASHTRA CHAPTER

In the month of September 2025, IIA Kalyan Dombivli Centre celebrated Teacher's Day and Engineer's Day along with ISSE and Rotary Club, Dombivli East.

Teacher's Day

Each year IIA Kalyan Dombivli Centre (KD Centre) celebrates Teachers' Day in a unique way by giving guest lectures in architectural colleges. This year too, IIA KD Centre celebrated the 3rd edition of Teacher's Day by organizing guest lectures in five colleges across Mumbai Metropolitan Region (MMR) from 8 to 10 September 2025. Accordingly, ten speakers from IIA KD Centre delivered guest lectures on the topic of 'Placement Training' in the colleges shown in the table. This is yet another effort by our Centre towards bridging the gap between profession and academics and betterment of students.

S. No	Name of College	Name of the Speakers
1	Pillai College of Architecture New Panvel, Maharashtra	Ar. Keshav Chikodi and Ar. Vinay Degaonkar
2	Dr. Baliram Hiray College of Architecture Bandra (E), Mumbai	Ar. Dhanashree Bhosale and Ar. Uday Satavalekar
3	Lokmanya Tilak College of Architecture Kopar Khairane, Navi Mumbai	Ar. Sandeep Paranjpe and Ar. Sarvesh Nandgirikar
4	Pillai HOC College of Architecture (PHCOA) Khalapur, Rasayani, Maharashtra	Ar. Anand Sahastrabhude and Ar. Ankur Shetye
5	Bharati Vidyapeeth College of Architecture CBD Belapur, Navi Mumbai	Ar. Ninad Vaidya and Ar. Vikas Padalkar

Ar. Keshav Chikodi and Ar. Vinay Degaonkar, along with faculty and students of Pillai College of Architecture, New Panvel

Engineers' Day

Engineers' Day is celebrated every year on 15 September to commemorate the birth anniversary of the legendary Bharatiya Engineer Sir Mokshagundam Visvesvaraya. This year Engineers' Day was jointly celebrated on 20 September 2025 by the *Indian Society of Structural Engineers* (ISSE), *Rotary Club of Dombivli East* (RCDE) and *IIA Kalyan Dombivli Centre* (IIA KD Centre) titled *Aapli Vasundhara : A Step towards Sustainability* which was sponsored by Ultratech Cement. The Honorable KDMC Commissioner Er. Abhinav Goel unveiled the Green Policy jointly signed by four organizations and highlighted the green initiatives taken up by KDMC. IIA KD Centre's member Ar. Aditya Agte presented a case study of the IGBC gold-rated building that he is developing in Thane, Maharashtra. Other notable speakers included former Chief Planner of Mumbai Metropolitan Regional Development Authority (MMRDA) Ar. Kedarnathrao Ghorpade, Er. Prashant Bhagwat, Executive Engineer KDMC, and Er. Aparna Bhandarkar from Ultratech Cement. Through this joint program, we have cemented our good relations with other parallel organizations which is part of our *Panchsutri* vision, and tried to reach citizens at large with the noble message of sustainability.

Centre: (Left to Right) – Ar. Rajeev Taishete, IIA CAD and Legal Committee Head; Ar. Keshav Chikodi, Chairperson, IIA KD Centre; Er. Madhav Chikodi, Chairman, ISSE, Kalyan Dombivli Unit; Er. Hemant Vadalkar, President, ISSE; Rtn. Dr. Sandeep Gharat, President, RCDE; Ar. Kedarnathrao Ghorpade; Er. Rohit Pandya, Regional Technical Head, Ultratech along with other dignitaries and attendees.

IIA TAMIL NADU CHAPTER

Visit to the Restoration / Conservation Project of the 210-year-old St. George's Cathedral, Chennai.

The IIA Tamil Nadu Chapter initiated a visit to the restoration/ conservation project of the 210-year-old St. George's Cathedral, Chennai, after learning about the works through the main turnkey contractor of the project, M/s. Edwin Construction, specialists in heritage conservation. The visit was arranged for both IIA Tamil Nadu Chapter members and students of architecture.

Participants of the visit to the ongoing conservation project at the St. George's Cathedral, Tamil Nadu

Ar. Fenn Rajarathinam, Past Chairperson of IIA Tamil Nadu Chapter and a member of the Cathedral Building Committee, spontaneously came forward to support the initiative. He played a key role in obtaining permission from the Pastorate Committee of the Cathedral and in facilitating the entire program, which included demonstrations and presentations conducted on two days- Saturday 13 and Sunday 14 September 2025. A total of 40 architect members and 40 students of architecture benefitted from the visit, gaining valuable insights into the techniques and processes involved in heritage restoration and conservation.

The visits were coordinated by the following members of M/s Edwin Construction: Er. Johny, Managing Director; Er. Shruthi, Conservation Engineer and Ar. Angeline, Conservation Architect.

They guided participants through material yard demonstrations, PowerPoint presentations, and detailed walk-throughs of the church interiors, premises, and terrace. A team of experts from IIT Madras, consultants to the project, contributed by sharing their knowledge on the structural aspects of the conservation work.

Repairs in masonry, preparation of lime mortar, application of regular and decorative lime plastering, execution of intricate patterns, terrace water proofing and structural repairs to long span wooden beams were some of the works seen in the visit. Mr. Jeyaraj, former Curator of the Government Museum, Egmore, elaborated on the conservation of stained glass and other antique artefacts of the church, with the support of archaeologists and artists. In addition, Ar. Zubair Ahmed, conservation architect, also a part of the visitors, shared additional explanations on materials and techniques adopted in such projects.

IIA Tamil Nadu Chapter sincerely thanks all the professionals and experts who volunteered their time and expertise, and gratefully acknowledges the support of the Cathedral authorities, whose cooperation made this program a success.

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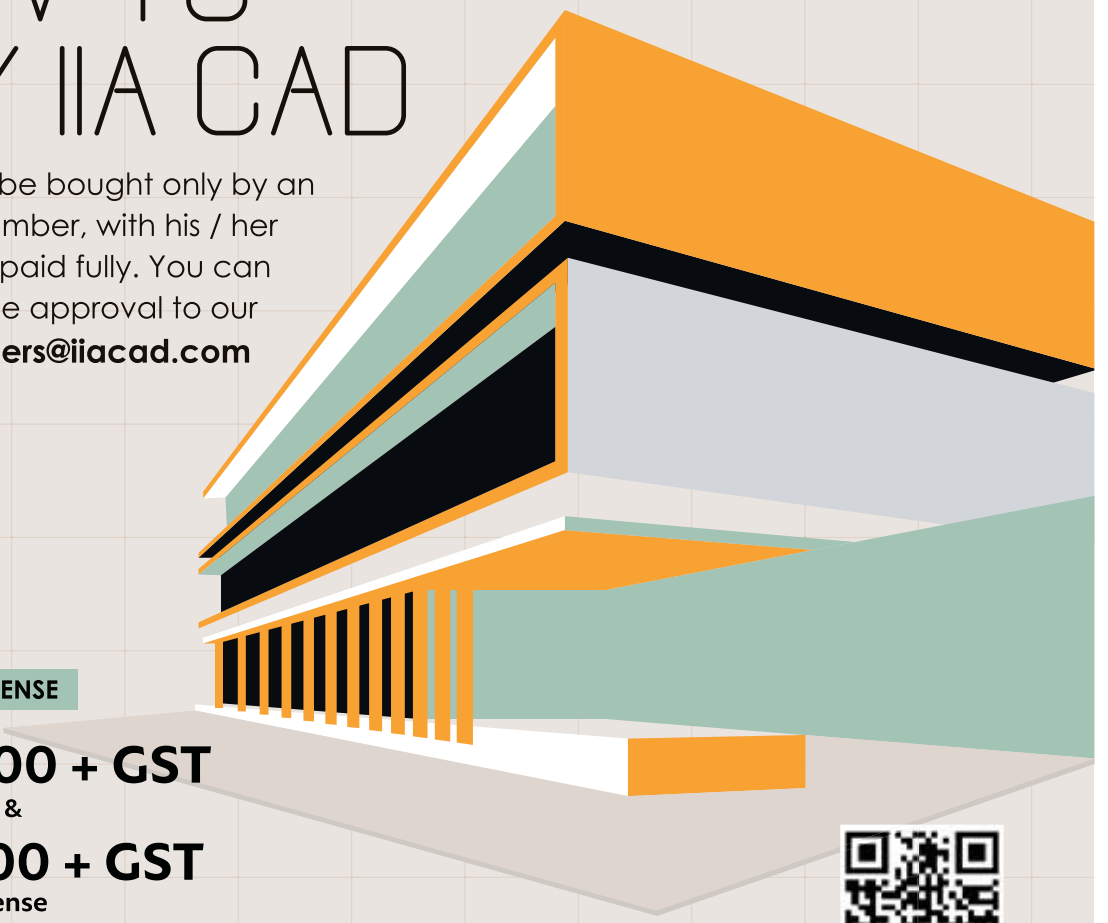

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