



PERI-URBAN ARCHITECTURE AND PLANNING

PRCA BOOK OF PROCEEDINGS 2023

ISBN: 978-81-960313-0-5

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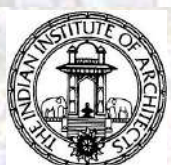
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(PADMA BHUSHAN AWARDEE)
PRAVARA RURAL EDUCATION SOCIETY'S
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OF ARCHITECTURE
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Virtual national conference on

**PERI–URBAN ARCHITECTURE AND
PLANNING**

February 2023

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Virtual national conference on

PERI-URBAN ARCHITECTURE AND PLANNING

2nd to 4th February, 2023

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First Impression: 2023

Pravara Rural College of Architecture, Loni

Virtual National Conference on Peri–Urban Architecture and Planning

ISBN: 978-81-960313-0-5

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PREFACE

Urbanization has brought about new challenges and opportunities for Urban and Peri-urban areas around the world. The Peri-Urban areas are a unique phenomenon of our time, as they represent the intersection of urban and rural landscapes and lifestyles. These areas are facing unprecedented challenges due to rapid urbanization and globalization. As a result, Peri-Urban architecture and planning have become increasingly important fields of study and practice.

The aim of the Peri-Urban Architecture and Planning conference was to bring together scholars, practitioners, and policymakers to discuss the latest developments, exchange ideas and experiences, and explore innovative solutions to the complex and dynamic challenges facing Peri-Urban areas.

The book of proceedings presents a selection of papers that were presented at the conference, reflecting the diverse and cutting-edge research in the field of Peri-Urban architecture and planning. The papers cover a wide range of topics, environment and ecology, Heritage and conservation, landscape, Socio-Economic aspects, Infrastructure planning, and the governance of Peri-Urban development. They provide insights into the complex and rapidly changing conditions of Peri-Urban areas and offer solutions for addressing the challenges faced by these regions.

We hope that this book will serve as a valuable resource for researchers, practitioners, and policymakers working in the field of peri-urban architecture and planning. It provides a snapshot of the state-of-art in the field and points to future directions for research, practice, and policy.

We would like to express our gratitude to all participants, who have contributed to the success of the conference with their insightful and thought-provoking presentations, and to the reviewers, who have helped to ensure the quality and relevance of the papers. We also wish to acknowledge the support of the Council of Architecture and Savitribai Phule Pune University, who have made the conference and this book possible.

Finally, we hope that this book will inspire further research and discussions on the role of Peri-Urban Architecture and Planning in shaping the future of our cities and their surrounding areas.

February, 2023

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Ar. Tejashree Thangaokar

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ACKNOWLEDGEMENT

We are highly indebted to Hon. Radhakrishna Vikhe Patil Chairman, Pravara Rural Education Society for his stimulus and direction for organizing such events of national importance.

We are grateful to Dr. Shivanand N. Hiremath, Additional C.E.O Pravara Rural Education Society for his positive attitude towards the theme of development of Peri-Urban architecture and help for this conference along with the administrative support.

We are extremely grateful to our Advisor Dr. Parag Narkhede for precious time and guidance. Ar. Tejashree Thangaokar, Principal, PRCA, Loni and Head of department were of great help in organizing this conference. Her timely aid was a right motivation.

We thank all the key note speakers, authors and participants for their scholarly contributions in achieving desired class of publication. We take this opportunity to express our sense of gratitude to the eminent academicians and professionals who have accepted our invitation to share their vast experience and expertise.

We acknowledge the useful suggestions and cooperation received from conference committee and all staff members.

We are also thankful to our sponsor Pravara Rural Education Society for sponsoring this event. Finally, we would like to thank our students, who were the main battalion behind this event.

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A perspective of Indian Urbanization process and Urban policies from independence time.

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Abstract: Urbanization is and Organic but vast process of development in terms of socio, cultural and economic consideration and in the last century the world's urban population has grown more than 15-fold and accounts for more than 56% population living in urban areas. India has practised a similar trend our urban areas are important by means of economy growth nation. India has the largest urban system in the world in terms of absolute population but it does not have any specific urban development policy as the city government and governance is constitutionally a matter of state and the center can only issue the guidelines and directives. Unfortunately, nothing substantial has been done at the state level, and whatever policy and program is seen has passed through various national plans. In this context, the paper intends to trace the urban development policies that have taken into account both urbanization policies and city policies since the first Five Year Plans. Urbanization policy focuses more on the development of urban areas in the regional context, while urban policy considers internal issues such as urban land use, housing and slums, basic services, transport and the urban management mechanism. When sifting through the literature, it was observed that a paradigm shift in urban development policy has taken place over time and the strategy has shifted from service providers to intermediaries or facilitators. Also New National Urban policy Framework concentrate more on decentralisation and flexible with development regulations to address future urban need on priority basis.

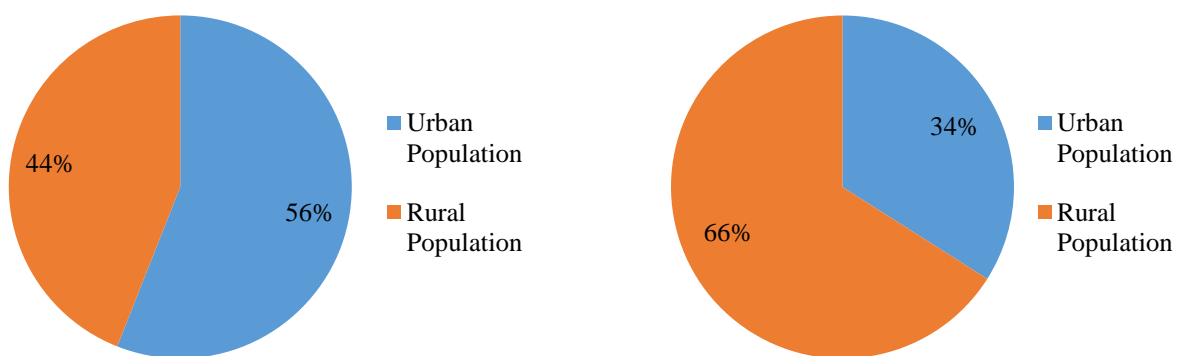


Fig: 1 World and India Scenario: Urban & Rural Population

Keywords: Urbanization, Urban Policy, (FYP) Five-year Plan, (WUP)World Urbanization Prospect, (NUPF) National Urban Policy Framework,(NITI)National Institution for Transforming India, Urban Agglomeration, Urban Mission, Urban Sprawl, In-situ...etc

1. Introduction : Currently, India is one of the largest urban systems in the world with 377 million people living in urban areas in 2011. The transition that will see India's urban population reach nearly 558.8 million by 2031 (MoHFW, 2019) is not just a demographic shift. It places cities and towns at the heart of India's development trajectory. In the coming decades, the urban sector will play a crucial role in the structural transformation of the Indian economy and in maintaining the high rate of economic growth. Accelerated job creation is proving to be a key issue in planning Indian urbanization in the larger context of its growth and development. Rapid spatial expansion and suburbanization has resulted in the addition of 91 urban agglomerations (UA) during the 2001-2011 census decade. In fact, the mushrooming of new census cities near potential UAs led to this increase and the consequent increase in urbanization levels. The emergence of census cities indicates a sectoral shift in the economy, manifested in in situ urbanization. Importantly, between 2001 and 2011, 2,530 census cities were added, compared to just 242 statutory cities. There are regional differences in the degree of urbanization. Southwest India, which includes Goa, Tamil Nadu, Kerala, Maharashtra, Gujarat and Karnataka, has a higher degree of urbanization. The Union Territories of Delhi and Chandigarh are also heavily urbanized. Some of the populous states of Uttar Pradesh and Bihar have a low level of urbanization.

As it is observed that, Urbanization is a natural consequence of socio-economic development in general and industrialization in particular. Widespread urbanization is a 20th century phenomenon. The total urban population of the world in 1900 was no more than 250 million, i.e. less than 15 percent of the total population. It has grown rapidly from 746 million in 1950 to 2.9 billion in 2000 and 3.9 billion in 2014. Globally, more people live in urban areas than in rural areas, with 56 percent of the world's population living in urban areas in 2014 (WUP-2014). In 1950, 30 percent of the world's population lived in cities, and by 2050, 66 percent of the world's population is projected to live in cities. The 21st century is therefore an urban century and differs from previous centuries (Mohan-2004). India has not faced an urban explosion like many other regions of the world. India's degree of urbanization increased from around 20 percent in 1961 to just 23.34 percent in 1981 and 31.16 percent in 2011 and 39.95 percent in 2020. Due to its low per capita income, India ranks in the bottom thirty in the list of countries ranked after their urbanization levels are listed (WUP-2011). Despite its low level of urbanization compared to other parts of the world, India's absolute urban population has more than quadrupled over the past 50 years (1961-2011), with 377 million people living in urban areas.

2. Indian Urbanization: Philosophy, Perspective from History to Early post-independence time Background (upto 1975):

Three fundamental difficulties that stand out strongly in the context of urbanisation policy are identified by Ramachandran (1989). First, there is the fundamental question of whether urbanisation is desirable on a global scale, which is sometimes expressed in the form of extreme positions on urbanisation, such as anti-urban and pro-urban philosophies. There has always been one school of thought and scholars that believes cities are bad and city living is the epitome of ills. The majority of the ancient and religious writings, including the Vedas and Upanishads, were against urban living.

On the other end of the spectrum are academics and thinkers like Kautilya and Vatsyayana, who supported urban life in their writings and maintained the belief that it is a characteristic of civilised civilization. These two frames of view essentially mirror the struggle in Aryan civilization for dominance and influence. Gandhi's aversion to urbanisation reflects contemporary anti-urbanization thinking, and any clear urbanisation strategy is still met with significant rejection.

The second concern is on the choice between a perfect decentralised urban settlement system and the alternative scenario of a highly centralised urban system with a few number of metropolises acting as the macroeconomic pillars. Gandhian thought supported a decentralised society and economy built on self-sufficiency, whereas British thought supported a highly centralised government in the capital

city, leaving little room for innovations at lower level. Urban decentralisation in a spatial context refers to the promotion of small and medium towns through establishing infrastructure, amenities, and employment opportunities while discouraging metropolitan areas.

The notion was evident in the founding of Provision of Urban Amenities in Rural Areas (PURA) in the first decade of the twenty-first century and Integrated Development of Small and Medium Towns (IDSMT) in the early eighties.

The third problem is related to our national political structure, in which urbanisation is treated as a state issue and only the state governments have the authority to pass laws. Sadly, the state governments have hardly made any efforts in this direction, and over the past 60 years, the majority of initiatives and interventions in the urban sector have come from the federal government through various five-year plans created by the Planning Commission (now NITI Aayog) and approved by the National Development Council, which is composed of the chief ministers of the states.

The Separation of Indian-Pakistan in 1947- 48 creates the background for urban development policy in India. Millions of refugees crossed the borders in East and West sectors, seeking shelter and livelihood in different cities. The output has been a unbelievable increase in partial graded housing and urban encroachments with unsanitary mud huts of poor construction, poorly ventilated, overcrowded and often without essential amenities such as water and light in urban areas. It was observed Urban raised during the first five-year plan was found to have been haphazard, caused by insufficient statutory powers to control land use and construction of buildings. Therefore, greater state/local control over construction, land use and land prices is needed (Shaw-1995). In reply to the issues caused by the sudden increase in urban population, the 1st Five Year Plan (1951-1956) dealt mainly with the housing and rehabilitation of refugees. A large number of rehabilitation colonies and Sub-cities, Sprawls were established in various divisions of the nation.

3. Part 1: (Urbanization)Urban Development Scenario (1952-2012)

Urbanization is a natural consequence of socio-economic development in general and industrialization in particular. Widespread urbanization is a 20th century phenomenon. The total urban population of the world in 1900 was no more than 250 million, i.e. H. less than 15 percent of the total population. It has grown rapidly from 746 million in 1950 to 2.9 billion in 2000 and 3.9 billion in 2014. Globally, more people live in urban areas than in rural areas, with 54 percent of the world's population living in urban areas in 2014 (WUP-2014). In 1950, 30 percent of the world's population lived in cities, and by 2050, 66 percent of the world's population is projected to live in cities. The 21st century is therefore an urban century and differs from previous centuries (Mohan-2004).

India has not faced an urban explosion like many other regions of the world. India's degree of urbanization increased from about 18 percent in 1961 to just 23.34 percent in 1981 and 31.16 percent in 2011. Due to its low per capita income, India ranks in the bottom thirty in the list of countries ranked after their urbanization levels are listed (WUP-2011). Despite its low level of urbanization compared to other parts of the world, India's absolute urban population has more than quadrupled over the past 50 years (1961-2011), with 377 million people living in urban areas. Surprisingly, India is the largest urban system, with an urban population larger than the total population of all countries except China and the United States and any other countries in west.(world orranization aspect)

Table 1: India's Population (1961-2011)

Year	No. Of Towns/UA	Total Population (Mill.)	Urban Population (Mill.)	Level of Urbanisation (%)	Exponential Urban Growth (%)
1961	2334	439	79 Mill.	17.97	-
1971	2567	548	109	19.91	3.23
1981	3347	683	160	23.34	3.79
1991	3769	846	218	25.72	3.09
2001	4378	1027	286	27.86	2.75
2011	4780	1210	377	31.16	2.76

(Source: Based on Census of India 1961-2011 volumes)

Urbanization is a spontaneous rather than an induced concept and is usually seen as a by-product of economic development, which is why it gets the peripheral attention of planners and policymakers. This is reflected in the budgetary spending envisaged in various five-year plans for the urban and housing sectors.

Table 2: Plan Outlay in Housing and Urban Development Sector (Rs. In Millions)

Plan and Year	Total outlay	Housing and urban development	Percentage share in the total
First Plan(1951-56)	20688	488	2.1
Second Plan (1956-61)	48000	1200	2.5
Third Plan (1961-66)	85765	1276	1.5
Annual Plan (1966-69)	66254	733	1.1
Fourth Plan (1969-74)	157788	2702	1.7
Fifth Plan (1974-77)	394262	11500	2.9
Annual Plan (1977-80)	121765	3688	3.0
Sixth Plan (1980-85)	975000	24884	2.6
Seventh Plan (1985-90)	1800000	42295	2.3
Annual Plan (1990-92)	1338350	3001	2.2
Eighth Plan(1992-97)	4341000	105000	2.4
Ninth Plan(1997-2002)	6473654	158800	3.5
Tenth Plan (2002-07)	9521214	405000	4.6
EleventhPlan(2007-12)	9185216	368700	4.1

Further, the fact remains that cities have played a significant role in the country's economic development and are seen as engines of economic growth. Data on the share of cities in the gross domestic product (GDP) of the Indian economy is not available regularly and consistently, but estimates from the Central Statistical Organization (CSO), which have been available for a number of years, suggest that this share has increased over a year period (Mohan-2004). The urban sector accounted for 27 percent of the country's gross domestic product (GDP) in 1950-51, 37.7 percent in 1970-71, 47 percent in 1980-81 and 52 percent in 2004-05. The mid-term review of the Eleventh Plan predicts that the urban share of GDP was 62.63 percent in 2009-10. In addition, more than 90 percent of government revenue comes from the urban sector. They have not only developed into primary settlement focal points for industry, but also functioned as a dissemination center for the promotion of agriculture.

3.1 Urban development policy: it is governments' Solution to understanding urban problems, approaching remedial measures, visualizing urban future and developing society; and its assessment can reveal many related concerns related to this specific area. (Biswas et al.-2013). India's Urban Vision strongly advocates the promotion of sustainable, efficient, well-governed and regionally balanced urban development in which the existing rural-urban, rural-urban dichotomy is to be replaced by a rural-urban continuum. It should facilitate the emergence of an articulated human settlement system with a well-defined regional hierarchy that integrates and strengthens urban centers and surrounding rural areas (HUDCO-HSMI-2002).

Rather than the positive action these cities have played in socio-economic development, a contrast in income and amenities is evident at the inter-urban, inner-city and rural urban levels due to the lack of rational urban development policies that take into account the socio-economic and cultural fabrics of the country, which remains intact. Such a policy should focus on strengthening local entities, improving urban planning, management and governance, reducing poverty, protecting the environment, promoting healthy and affordable housing, and cost-effective and efficient infrastructure and service systems with the overall goal focus on improving the quality of life of city dwellers. Any urbanization policy has a dual effect: first, it is seen in the inner parts of the city, and second, it is reflected in the surrounding outskirts.

simultaneously, any urban development policy should have two components: first, urbanization and second, urban policy framework vision, and the main goal of Indian urban development policy is to develop an urban-rural continuum, which on the one hand replaces the existing urban-rural dichotomy and maintains the minimum level of basic Services and amenities within the urban areas, regardless of the class, caste and status of the people on the other side. Urbanization policy is increasingly focusing on the expansion of infrastructure in small, medium-sized and medium-sized towns in order to turn them into growth centers in the rural neighbourhood and curb rural migrations.

When we talk about such a policy, we first need a policy on the role of urban places, regardless of their size and function, in the context of the whole settlement system, which is the domain of urbanization policy. Such issues should cover three main aspects:

- (a) city size and distance policies,
- (b) rural-urban migration policies and
- (c) rural-urban fringe policies,

and secondly, we need to establish a clear policy on the internal issues of cities viewed as urban policies, encompassing unregulated urban land use, poverty and slums, transport, city governance, housing, habitat and environment.

3.2 Efforts and Initiatives of Government:

The Government of India set up a task force in October 1975 to study the problems of small and medium-sized towns in India and the report made it clear that balanced urban development requires a multi-dimensional approach that integrates spatial, social and economic aspects of the development includes. In the realm of human settlements, it visualized a settlement system that is functionally distinct but woven into an integrated pattern of complementarity, each with its own personality and character.

In accordance with the report, the Town and country Planning Organization (TCPO), the Indian Government's Department of Urban Development, drafted a National Urbanization Policy in 1975 with the following objectives:

- Ensure the distribution of economic activities in small and medium-sized towns and in new growth centres to achieve maximum economic growth.

- Ensuring an optimal distribution of population between rural and urban settlements and between the different sized towns within each region.
- Controlling/inhibiting the further growth of metropolises by diversification of economic activities, legislative measures and establishment of new counter magnets in the region.
- Development of a spatial pattern of economic development and site hierarchy of settlements in accordance with the use of natural and human resources and ensuring functional linkages.
- Providing a minimum level of services to improve the quality of life and reduce the rural-urban divide.

According to the policy statements, the Class I cities (population over 1 lakh) should be industrially developed with adequate infrastructure so that they can act as a counter-magnet to the metropolises; the medium-sized cities (population between 50,000 and 1,00,000) are to be developed as growth centers with agricultural industry and small towns (population below 50,000) to function as rural service centers to meet the needs of the surrounding rural areas. The Government of India established the National Commission on Urbanization (1985), which in its report (1988) reiterated decentralized urban growth through the dispersal of economic activities. Focused investments in selected cities based on their potential to generate economic Momentum (GEM) were seen as a viable strategy.

Table 3: Priorities and Criteria to select GEMs

Type of City	Selection base Criteria
National Priority Cities <ul style="list-style-type: none">• All states/UT capitals• All million plus cities and those cities likely to become million plus cities by 2001• All cities having potential for being GEMs• Cities of administrative or social significance	<ul style="list-style-type: none">• Administrative status.• Population plus economic growth potential.• Economic growth potential.• Administrative and social factors.
State Priority Cities <ul style="list-style-type: none">• Class I cities (population 1 lakh plus) having potential to become GEM• Regional Centre• Rural (Country side) District HQ• Small town with population above 20,000	<ul style="list-style-type: none">• Population, proportion of workers in manufacturing and construction work during 1961-81 above national average.• District with more than 30 per cent urban population.• District with more than 90 per cent of rural population.• Population with economic, social and environmental factors

On this basis, the commission identified 329 cities as GEMs, 77 of them under national priority cities and 252 state priority cities. Although extensive analysis has been carried out to measure the cities' growth potential by examining the demographic, economic and administrative factors at the micro level, the NCU itself acknowledged that the list is not exhaustive but only provides a frame of reference for further analysis.

In addition to GEMs, national and state focus centres, the Commission has also identified 49 Spatial Priority Urban Regions (SPURs). Future urbanization growth should occur along these nodes and

corridors. In this way, IDSMT remained the key program for the urban sector under the Seventh Plan, and in light of the NCU recommendation, the program's reach was expanded to 102 additional cities.

3.3 Urban Development Policy through Five Year Plans:

Table: 4 Major policy measures for urban development under India's Five Year Plans

Plan Period	Major urban development programmes
First Five Year Plan (1951-56)	Main importance was given for construction of institution building, houses for government employees, refugees and weaker section of the people under the Centre subsidized scheme.
Second Five Year Plan (1956-61)	1. Industrial Housing Scheme was broadened to include all workers. 2. Preparation of Master Plans (e.g., Delhi Development Authority (DDA)) for important towns by setting up the Town & Country Planning Legislations.
Third Five Year Plan (1961-66)	1. Through urban planning and land policy measures imbalance and asymmetry were sought to be removed in the development of large, medium, and small industries, and between rural and urban areas. 2. The State capitals of Gandhi Nagar and Bhubaneswar were developed and Master Plans for important cities were prepared.
Fourth Five Year Plan (1969-74)	1. To provide fund for housing and urban development programs, Housing & Urban Development Corporation (HUDCO) was established. 2. The creation of smaller towns and plan for the spatial location of economic activity were envisaged for decongestion of population in the large cities. 3. To provide a minimum level of services, like, water supply, drainage, sewerage, street pavements in 11 cities with a population of 8 lakhs.
Fifth Five Year Plan (1974-79)	1. Urban Land (Ceiling & Regulation) Act came into existence in 1976. 2. In order to ease the increasing pressure on urbanization a Task Force was set up by giving particular emphasis on a comprehensive and regional approach by considering the problem in metropolitan cities.
Sixth Five Year Plan (1980-85)	1. To encourage setting up the new industries, commercial and professional establishments in small, medium and intermediate towns, positive inducements were suggested. 2. The Integrated Development of Small and Medium Towns (IDSMT) was launched in towns with population below one lakh for provision of roads, pavements, minor civic works, markets, shopping complex, bus stands, etc.
Seventh Five Year Plan (1985-90)	1. To expand the base of housing finance, the National Housing Bank was set up 2. For the first time, this Plan considered the problem of the urban poor. Urban Basic Services for the Poor (UBSP), Global Shelter Strategy (GSS), and National Housing Policy (NHP) were announced in 1988.
Eighth Five Year Plan (1992-97)	1. The Constitution (74th) Amendment Act came into existence in 1993 to improve municipal governance at the grass roots. 2. The Plan identified the role and importance of urban sector for the national economy and recognized the significance of the following issues: i. Poor suffered due to huge gap between demand and supply of infrastructural services.

	<ul style="list-style-type: none">ii. Housing shortage caused by the unabated growth of urbanization.iii. Higher level of incidence of urban poverty and marginal employment.
Ninth Five Year Plan (1997–2002)	<ul style="list-style-type: none">1. The Swarna Jayanti Shahari Rozgar Yojana (SJSRY) launched with its two components i.e Urban Self Employment Programme (USEP) and Urban Wage Employment Programme (UWEP).2. National Slum Development Programme (NSDP) launched in 1997 by merging NRY and PMIUPEP.
Tenth Five Year Plan (2002-07)	<ul style="list-style-type: none">1. Strengthening urban governance through devolution of functions and funds to the elected bodies and ULBs.2. The repeal of the Urban Land (Ceiling and Regulation) Act, 1976 was a significant step towards reform in the urban land market.3. Mapping, urban indicators and data from the urban sector based on aerial photography.4. Improvement of civic amenities in urban areas through improvement in urban water supply, urban sanitation, and urban transport.
Eleventh Five Year Plan (2007-2012)	<ul style="list-style-type: none">1. Jawaharlal Nehru National Urban Renewal Mission (JNNURM).2. Pooled Finance Development Fund (PFDF)3. Development of satellite cities/counter Magnet cities4. E-governance in municipalities National Urban Information System (NUIS).5. National Capital Region Planning Board (NCRPB).6. Strengthening urban local bodies through capacity building and better financial management.7. Increasing the efficiency and productivity of cities by deregulation and development of land.8. Dismantling public sector monopoly over urban infrastructure and creating conducive atmosphere for the private sector to invest.
Approach to the Twelfth Five Year Plan (2012-17)	<ul style="list-style-type: none">1. Rapid Mass Transport (RMT) for better transportation system.2. Reform of the urban water sector.3. Efficient use of urban land.4. Long term strategic urban planning with the overall regional planning perspective.5. The environmental sustainability of urban development.6. Investment in new urban infrastructure assets and maintenance of assets.7. Need to strengthen urban governance8. To strengthen the ‘soft infrastructure’

4. Part 2: Urbanization and Urban Development Policies (from 2014 to present)

Integrating these facts, the NUPF aims to enhance economic opportunity through a series of interventions at all levels (city, state and national) that could lead India to a \$5 trillion economy. The areas of intervention follow:

- Creating plans and sustainable physical infrastructure to support enhancing ‘economic base’ of urban areas.
- Boosting local economy through set-of enablers (finance, infrastructure, policy, regulation, institutional support and governance) to provide necessary social infrastructure including housing, informal sector livelihood, common services platforms for networking etc.

- Promoting mass public transport systems, non-polluting modes, promoting pedestrian safety and cycling (to achieve safer and healthy cities)
- Enhancing the finances of urban local bodies, devolving powers to lead, set-outcome based targets and leverage financial resources independently.
- Create real-time urban information hub at local level, integrated with the regional, state and national level database for informed decision making.
- Establish systems and technology to ensure environment sustainability to minimize negative impact and improve urban resilience (including readiness for manage pandemic).

India's response to urbanization recognizes the international benchmarks, as set out in the 2030 Sustainable Development Goals (SDGs), the Paris Climate Agreement and the New Urban Agenda (NUA). Given the growing importance of the urban sector, India has stimulated the growth of this sector by launching six missions:

4.1 Urban Missions: Atal Mission for Rejuvenation and Urban Transformation (AMRUT); Pradhan Mantri Awas Yojana (PMAY) – housing for all (Urban); Smart Cities Mission (SCM); Swachh Bharat Mission (SBM); Heritage City Development and Augmentation Yojana (HRIDAY) and Deen Dayal Antodaya Yojana National Urban Livelihoods Mission (NULM) along with plans and programs to improve urban mobility. The missions aim to improve the quality of life in urban areas. Integrated into the missions (AMRUT and PMAY) is a series of accompanying reforms aimed at improving city services, making city functioning more transparent and officials more accountable.

Table 5 : Urban Missions and Schemes

Missions	Major Agendas and Policies
Atal Mission for Rejuvenation and Urban Transformation (AMRUT)	<ul style="list-style-type: none"> • Ensure that every household has access to a tap with the assured supply of water and a sewerage connection. • Increase the amenity value of cities by developing greenery and well maintained open spaces (e.g. parks) and • Reduce pollution by switching to public transport or constructing facilities for non-motorized transport (e.g. walking and cycling). <p>Components:</p> <ul style="list-style-type: none"> • Water Supply • Sewerage • Storm Water Drainage • Urban Transport • Green Spaces Parks
Pradhan Mantri Awas Yojana (PMAY) – housing for all	<p>Provision of Housing Infrastructure at all urban level.</p> <p>Component:</p> <ul style="list-style-type: none"> • In-situ Slum Redevelopment (ISSR) • Credit Linked Subsidy Scheme (CLSS): • Affordable Housing in Partnership (AHP) • Beneficiary-led Individual House Construction/ Enhancement

Smart Cities Mission (SCM)	<p>The main objective of the Mission is-</p> <ul style="list-style-type: none"> • to promote cities that provide core infrastructure, clean and sustainable environment and give a decent quality of life to their citizens through the application of ‘smart solutions’. • The Mission aims to drive economic growth and improve quality of life through comprehensive work on social, economic, physical and institutional pillars of the city. • The focus is on sustainable and inclusive development by creation of replicable models which act as lighthouses to other aspiring cities. <p>Prospectus:</p> <ul style="list-style-type: none"> • Community at the core • More from less • Cooperative and competitive federalism • Integration Innovation Sustainability • Urban Technological Advancement • Convergence
Swachh Bharat Mission (SBM)	<p>Mission Objectives:</p> <ul style="list-style-type: none"> • Elimination of open defecation • Eradication of Manual Scavenging • Modern and Scientific Municipal Solid Waste Management To effect behavioural change regarding healthy sanitation practices • Generate awareness about sanitation and its linkage with public health • Capacity Augmentation for ULBs to create an enabling environment for private sector participation in Capex (capital expenditure) and Opex (operation and maintenance) <p>Components</p> <ul style="list-style-type: none"> • Household toilets, including conversion of insanitary latrines into pour-flush latrines • Community toilets, • Public toilets and urinals • Solid waste management • IEC & Public Awareness • Capacity building and Administrative & Office Expenses <p>Mission Strategy</p> <ul style="list-style-type: none"> • Comprehensive Sanitation Planning, which includes

	<ul style="list-style-type: none"> • City level sanitation plans • State Sanitation Concept as per Annexure IV • State Sanitation Strategy • Behavioral Change Strategy • IEC Enabling Environment for Private Sector Participation Capacity Building • Special Focus Groups
Heritage City Development and Augmentation Yojana (HRIDAY)	Scheme Statement : Preserve and revitalise soul of the heritage city to reflect the city's unique character by encouraging aesthetically appealing, accessible, informative & secured environment. To undertake strategic and planned development of heritage cities aiming at improvement in overall quality of life with specific focus on sanitation, security, tourism, heritage revitalization and livelihoods retaining the city's cultural identity.
National Urban Livelihoods Mission (NULM)	Mission Statement : To reduce poverty and vulnerability of the urban poor households by enabling them to access gainful self employment and skilled wage employment opportunities, resulting in an appreciable improvement in their livelihoods on a sustainable basis, through building strong grassroots level institutions of the poor. The mission would aim at providing shelters equipped with essential services to the urban homeless in a phased manner. In addition, the mission would also address livelihood concerns of the urban street vendors by facilitating access to suitable spaces, institutional credit, social security and skills to the urban street vendors for accessing emerging market opportunities.

4.2 Indian Issues/Problems in Urbanization : Urbanization is an integral part of the process of economic growth. As in most countries, India's cities and towns are major contributors to the country's economy. With less than 1/3 of India's population, urban areas generate over 2/3 of the country's GDP and account for 90% of government revenue. Urbanization in India has been expanding rapidly as more and more people are migrating to the cities and towns in search of economic opportunity. Slums now make up 1/4 of all urban housing. In Mumbai, for example, more than half of the population lives in slums, many of which, unlike most other developing countries, are close to work places in the heart of the city. Meeting the needs of India's growing urban population is and will therefore continue to be a strategic policy matter. Meeting the needs of India's soaring urban populations is and will therefore continue to be a strategic policy matter. Critical issues that need to be addressed are:

4.2.1 Policy base Execution Problems:

- Poor local governance
- Weak finances
- Inappropriate planning that leads to high costs of housing and office space; in some Indian cities these costs are among the highest in the world

- Critical infrastructure shortages and major service deficiencies that include erratic water and power supply, and woefully inadequate transportation systems
- Rapidly deteriorating environment

4.2.2 Planning Issues:

- Many urban governments lack a modern planning framework
- The multiplicity of local bodies obstructs efficient planning and land use
- Rigid master plans and restrictive zoning regulations limit the land available for building, constricting cities' abilities to grow in accordance with changing needs.

4.2.3 Housing:

- Building regulations that limit urban density - such as floor space indexes – reduce the number of houses available, thereby pushing up property prices.
- Outdated rent control regulations reduce the number of houses available on rent – a critical option for the poor.
- Poor access to micro finance and mortgage finance limit the ability of low income groups to buy or improve their homes.
- Policy, planning, and regulation deficiencies lead to a proliferation of slums.
- Weak finances of urban local bodies and service providers leave them unable to expand the trunk infrastructure that housing developers need to develop new sites.

4.2.4 Service delivery:

- Most services are delivered by city governments with unclear lines of accountability.
- There is a strong bias towards adding physical infrastructure rather than providing financially and environmentally sustainable services.
- Service providers are unable to recover operations and maintenance costs and depend on the government for finance.
- Independent regulatory authorities that set tariffs, decide on subsidies, and enforce service quality are generally absent.

4.2.5 Infrastructure:

- Most urban bodies do not generate the revenues needed to renew infrastructure, nor do they have the creditworthiness to access capital markets for funds
- Urban transport planning needs to be more holistic – there is a focus on moving vehicles rather than meeting the needs of the large numbers of people who walk or ride bicycles in India's towns and cities.

4.2.6 Environment:

- The deteriorating urban environment is taking a toll on people's health and productivity and diminishing their quality of life.

5. Efforts and Initiative from Government : This National Urban Policy Framework (NUPF) outlines an integrated and coherent approach to the future of urban planning in India. The NUPF is not an attempt to provide a detailed top-down guide to Indian city building and management. It recognizes that most urban problems are the responsibility of states or urban local bodies and that solutions need to be adapted to the local context. One of the starting points of NUPF 2020 is that the imposition of a standardized, strictly codified regulation is not desirable. A set of ten sutras (philosophies) and their corresponding functional areas were developed into a list of priorities, actions, and outcomes later in this document. This strategic intent takes the form of a guide that states must follow in formulating their city policies. In to the Functional Areas The NUPF recognizes the diversity of challenges in urban India and therefore the framework follows a 'loose fit, light touch' approach, based on ten sutras (principles) which are applied to various functional areas. The framework is divided into ten sections, each addressing a different functional area as listed below:

1. Urban Planning
2. Urban Economy
3. Physical Infrastructure
4. Social Infrastructure
5. Housing and Affordability
6. Transportation and Mobility
7. Urban Finance
8. Urban Governance
9. Urbanization and Information System
10. Environmental Sustainability

6. Conclusion:

- India's urban vision advocates the promotion of sustainable, efficient, well-governed and regionally balanced urban development.
- Constitutionally, legislation, planning and management of urban areas fall within the purview of state governments, but unfortunately little initiative has been taken over the past six decades and most interventions in the urban sector have come from the central government through various five-year plans.
- Widespread urbanization over the last century has been so pervasive that the world's total urban population has increased more than 15-fold over the past 115 years, with claims claiming that more than half i.e. 54 % of the world's population live in urban areas.
- India's level of urbanization (31.16 percent in 2011) is not as impressive compared to other parts of the world. But at the same time, India has the largest urban system in terms of absolute urban population at 377 million, with an increase of more than fourfold over the last 50 years (1961-2011).
- These plans have reflected the state's intentions for urban development and accordingly experienced a shift in focus over time. In the founding phase, the government was more concerned with providing houses, developing new colonies and creating institutional infrastructures such as SPA- school of planning and architecture, TCPO- town and country planning organization, etc. for the training of the professionals in the field of urbanization.
- This was followed by involving the private sector in the housing sector, providing funds for housing and urban development, and ceiling urban land for individuals.

- For decentralized urban development, the aim was to spread economic activities to the outskirts and promote small and medium-sized towns as initiators (GEM). In the last decade of the 20th century, there was an excess of reforms and the focus was on empowering people, especially weaker and more vulnerable sections of society, and a participatory approach to city governance in a transparent and accountable way.
- Urbanization is usually seen as a by-product of economic development and thus receives little attention from planners and policy makers.
- The fact remains, however, that cities have played a significant role in the country's economic development and are considered the engine of economic growth, with around two-thirds of gross domestic product (GDP) coming from this urban area.
- New Policy frameworks like NUPF 2020 is that the imposing of a standardized, strictly codified regulation is not desirable. A set of ten sutras (philosophies) and their corresponding functional areas were developed into a list of priorities, actions, and outcomes later in this document. So flexibility and function base need will be preferred for the solution of our future urban problems.
- Central Governments urban - six new missions are more promising and focusing towards the urban issue in a new and innovative way to handle urban encounters. For its review one should wait till the certain time passes, hopefully it would solve urban issues and problems of Indian cities.

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Development of Lake Conservation Projects in Nagpur, Maharashtra

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Theme: Natural and Cultural Landscape

Abstract: Lakes are an inherent part of the ecosystem. Lakes have traditionally served the function of meeting water requirements of the population for drinking, household uses like washing, for agriculture, fishing, and also for religious and cultural purposes. Apart from these functions which involve direct use of the lake water, lakes are also known to recharge ground water, channelize water flow to prevent water logging and flooding. Lakes are also host to a wide variety of flora and fauna, especially birds.

The need to initiate efforts to restore, conserve, manage and maintain the lakes as a valuable part of the whole ecosystem could no longer be ignored. Government at Nagpur realizes that if the lakes are not conserved without loss of time, the restoration costs later will not only reach phenomenal heights, but will more importantly cause a permanent ecological damage. This may lead to scarcity in potable water, causes heat islands in the cities and affect biodiversity in cities as well as villages.

With this background, the aim of this paper intends to develop and conserve the lakes in Nagpur city. There are 11 lakes in Nagpur. The main objective of this paper is to explore the possibility to work in close partnership with the private sector in protection, conservation and sustainable management of lakes.

The methodology adopted to this study has been conducted to assess the feasibility of conserving the lakes at identified locations (identification based on pre-determined parameters) in Nagpur and the possibility of taking up the conservation of identified lakes on a PPP model. The Government at Nagpur may consider providing funds through the viability gap funding (if required) for the implementation of projects.

Keywords: Lake, Conservation, Development, Nagpur

1. Introduction:

India is facing a serious problem of natural resource scarcity, especially that of water in view of population growth and economic development. Most of fresh water bodies all over the world are getting polluted, thus decreasing the potability of water. All life is depend on water and exists in nature in many forms like ocean, river, lake, clouds, rain, snow and fog etc. However, strictly speaking chemically pure water does not exist for any appreciable length of time in nature. A lake is a large body of water surrounded by land and inhabited by various aquatic life forms. Lakes are subjected to various natural processes taking place in the environment, such as the hydrological cycle. The degradation of lake has occurred not only due to waste water effluent inflow but also by saltation, domestic sewage, immersion of idols and other activities around the lake. Thus, the lake is subjected to enormous anthropogenic stress; the overall impact has resulted in the deterioration of the water quality, accumulation of toxic chemicals and sediments, shrinkage of lake area and above all, loss of the aesthetic value. Several investigations and research studies have been made on water quality and increasing pollution level of the water body. They all indicate the alarming contamination of the lake

which is very high as compared to the standard guidelines, revealing that nutrient load in the lake is very high and hyper eutrophic conditions are prevailing. Hence periodic monitoring and preventive measures are required to save the lake from eutrophication. The urban lakes have always served as an important source of water for the people living around the lake. They were constructed in such a manner that they harvest all the runoff rainwater from the surrounding areas along with organic components. People living nearby areas use this lake for various purposes like bathing, washing and immersion of idols. Other solid wastes are also dumped in these lakes which increase organic pollution of the lake. As a result, most of the lakes are directly and indirectly become eutrophic affecting its designated use for aesthetic purpose or domestic use or public supply. It is the need of the day to carry out water quality assessment thoroughly to identify the process and causes of pollution and identification of potential mitigation measures for restoration of lakes to their designated use.

The main problem in Lakes of Nagpur locality of Maharashtra state has arisen due to discharge of domestic sewage and effluents from upstream and surrounding residential areas. During rainy season the run-off brings the eroded topsoil from the catchment which settled in the lake causing turbidity in lake water. Release of wastes through inlet streams contributed to the internal nutrient loading of the lake. Immersion of idols has been in practice since a very long time. This has increased the nutrient load and concentration of toxic heavy metals in the lake water, Henceforth, there is urgent need to study the significance of lakes situated in Nagpur for Conservation. An examination of the traditional uses of these lakes, their ecology and structure is helpful in understanding how it may be possible to develop urban oriented by assessment of water quality, rejuvenation and restoration of selected lakes which will be ecologically and socially inclusive. This study deals with assessment of quality of lakes of Nagpur city. The purposes of this study was also to assess the status of the lakes and to provide the information of the Nagpur city to take action for Rejuvenation and Restoration of the lake and prevent the lake water from deterioration.

2. Water resources:

Nagpur city gets raw water from three different surface sources, viz., Gorewada tank, Kanhan River, and Pench canal. The sources have been developed over a period of time. Maximum amount of water is drawn from Pench schemes and Kanhan at present. Pench is a reservoir.

There are several natural water bodies within the city including 11 lakes, 2 rivers, and 5 nallahs. The lakes are Gorewada, Ambazari, Futala, Gandhisagar, Sonegaon, Sakkardara, Pandhrabodi, Naik Talao, Lendi Talao, Police Line Takli and Binaki Mangalwari.

The Nag and Pili rivers cut across the city and are 15.73 km and 12.11 km in length, respectively. Besides these, Chamar Nallah, Shakti Nagar Nallah, Hudkeshwar Nallah, Swawalabmi Nagar Nallah, and Sahakar Nagar Nallah also pass through the city.

Apart from this, ground water is another of the source of water, which is used for various purposes like drinking, washing, bathing, etc. The depth of ground water table in the central part of the city is about 1.65-1.95 m, and it can go up to 16 m in the peripheral areas. The Central Groundwater Board (CGB) has estimated that ground water availability in Nagpur can be up to 25 million cubic meters (MCM) per year.

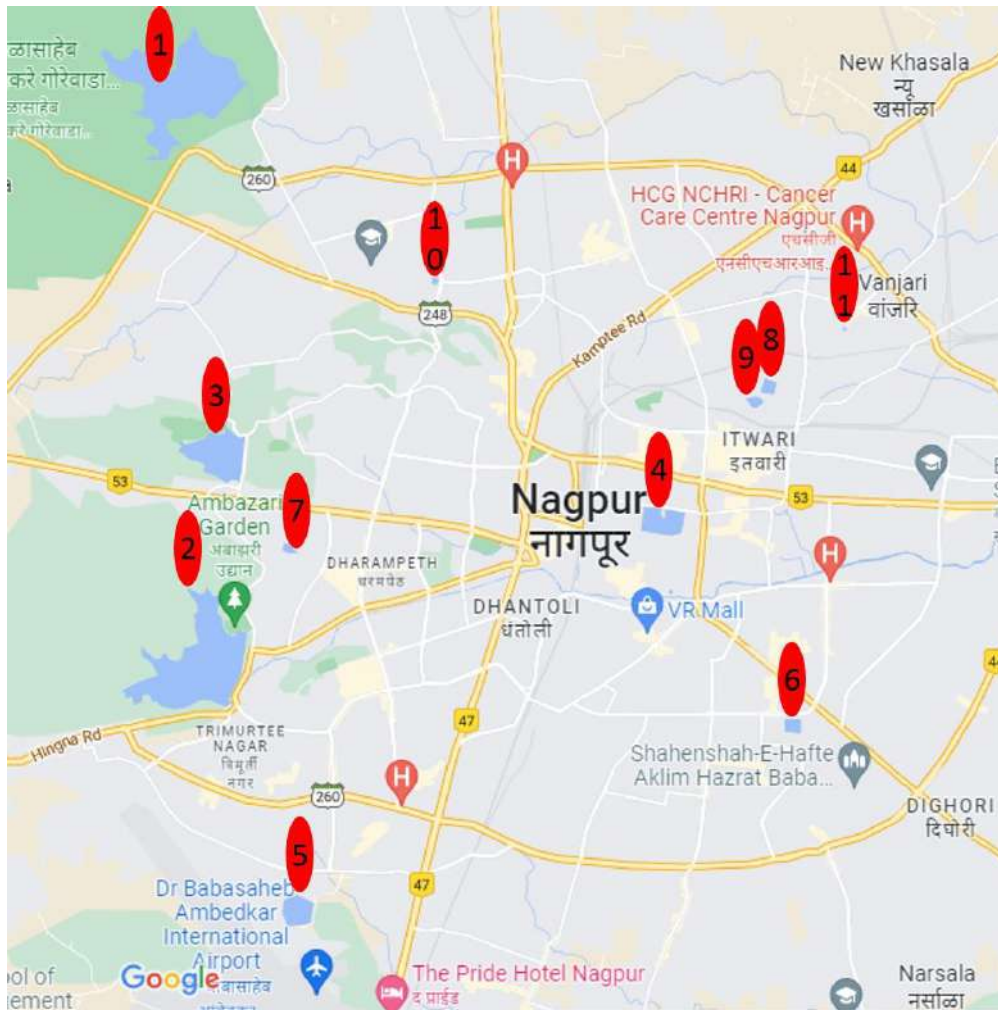


Figure 1: Map showing lakes of Nagpur -1 Gorewada, 2 Ambazari, 3 Futala, 4 Gandhisagar, 5 Sonagaon, 6 Sakkardara, 7 Pandhrabodi, 8 Naik Talao, 9 Lendi Talao, 10 Police Line Takli, 11 Binaki Mangalwari

3. Why people use lake:

Following table shows the use of lake by different users for different purpose.

Table 1: User requirements according to user index			
Sr.N	Elements	User Requirements	User Index
1	Users and Activities	Diverse group of people	Children, youngsters, adults, elderly, men, women
		Diverse type of activity and use frequency	Jogging, strolling, sitting, playing, exercising, yoga, meditation, fishing, boating, eating, shopping, relaxing, watching peoples' activities, watching and photographing wildlife, bird watching
2	Access and Linkages	Easy to get to and connectivity to the surrounding community	Accessibility to the lake
			Connectivity with the neighborhood
3	Comfort and	Comfort	Sitting provisions, sheltered spaces and

	Image		shading devices, ease of walking, pavements, noise level, street furniture, food facility
		Safety	Boundary/safety walls, railings, lighting, policing, antisocial activities
		Cleanliness	Waste bins, restrooms, maintenance
		Attractiveness	Contact with nature, vegetation, landscape, quality of water, skyline, visibility from road
4	Sociability	Social contact a) Overt (getting together) b) Covert (privately)	Provisions to facilitate interactions with people and nature, sitting arrangements, Cultural/heritage elements, social events and celebrations, kids play zones

4. Existing condition of lakes:

Since historic times, apart from serving as storage tanks these lakes also fulfilled the purpose of recreation. The religious significance of the lakes is evident from the fact that most of them are still having historic temples along their banks. The extreme climate of the city with hot summers and moderate rainfall furthermore enhances the significance of these lakes in balancing the temperature. Hence they enjoyed an indispensable position within the city fabric and always had a close association with the people and their settlements.

i. Gorewada: It is the largest one with an area of 157 hectares. It is situated in the northwest corner at outskirts of the city and as the city's primary source of drinking water.

Moreover, Gorewada Lake surrounded by dense forest serves as a home for large bio-diversity in terms of varied flora and fauna and regarded as bird watcher's paradise where people enjoy watching and photographing birds and wildlife. The lake is mostly used by nature lovers, while families with children are not keen to use it due to lack of children's play equipment. This lake does not have a paved pathway which makes the walking trail more natural and ecologically more supportive whereas the rest of the lakes have properly paved pathways used as jogging tracks. Interestingly, though nature's trail appears a bit uncomfortable particularly for use during harsh climatic situations, it is still preferred by the people compared to paved pathways because of its naturalness.

This lake is situated in nature dominant setting with a green cover on all its sides with the minimal human intervention appears to the viewers with no buildings seen at the periphery whereas exactly opposite in case of other lake. Gorewada though being admired for its scenic beauty is not much visited because of its location away from the city and less connectivity in terms of local transport.

ii. Ambazari: It is situated near the western border of Nagpur with area of 155 hectares. It was built in 1870 under Bhonsla regime. It is the largest and the most beautiful lake in the city. Nag River of Nagpur originates from this lake. The beauty of the lake is complemented by a well-kept garden, which is situated close to the lake, created in 1958, it covers an area of approximately 20 acres (8.1 ha). The garden is called the Ambazari Garden. Ambazari Lake is well known for its garden placed at one of its sides and no development zone on other sides. People also carry out activities like performing yoga, exercising, and meditation in the calm and quiet surroundings, particularly during early morning hours and attracts a large number of adults and elderly people of both genders. Ambazari lakefront garden is visited majorly by the families due to the presence of children's play equipment.

Ambazari being rich in bio-diversity, attract a lot of bird watchers from all over the city, particularly in early morning hours. Apart from the garden side, Ambazarilake is not much accessible for the public from other places due to the high retaining wall along roadsides. It not only acts as a physical barrier but also restricts visual access. But the overflow of water during rainy season makes this retaining wall as pubic entertainment zone.

iii. Futala: It is also an ancient lake built about 200 years ago by Bhonslas also known as Telangkhedhi. It extends over an area of 40 hectares. In the evenings the place is illuminated with

halogen lights. The lake is surrounded on three sides by forest and a landscaped Chowpatty on one side. Futala Lake is having an institutional zone on one side and no development zone on the rest of the sides.

Since Futala lakefront does not have provision for either outdoor gymnasium or children's play area, it discourages active engagements but at the same time attracts passive engagement because of design elements like series of wider steps and wider stone safety walls used for sitting at the edge of the lake which are cherished by the youngsters. Hence prime user group found here is the younger people reason being such wider walls give them the opportunity to be in close vicinity with the lake and at the same time encourages interaction. Futalalake is also made universally accessible by providing ramps at regular intervals.

Futala being rich in bio-diversity, attract a lot of bird watchers from all over the city, particularly in early morning hours. This lake lacking in vegetation cover, are used only during morning and evening times.

iv. Gandhisagar: It also known as Shukrawari lake, built by Chand Sultan, the then ruler of the city for supplying water to the city is existing for 275 years and stretched over 18 hectares of land. He created the water body in the form of streams being diverted to the Nag River, which was connected to the water reservoir and named it as 'Jumma Talab'.

Gandhisagar lake is positioned in the old city area surrounded by roadway amidst a busy commercial zone, which depicts a very high degree of human intervention in the form of tall buildings and haphazard development at its periphery. It has also got a unique feature in the form of an island garden set at the center of the lake. This has defined and diversified activities thereby promoting public health concerns apart from active recreation and passive interaction and attracts a large number of adults and elderly people of both genders. Gandhisagar Island garden are visited majorly by the families due to the presence of children's play equipment.

Gandhisagarlake, though being physically and visually accessible from all sides, still not much preferred by people except its island garden because of surrounding heavy traffic roads. Shiv and Ganesh Temples at Gandhisagar lakefront narrate and support the local cultural legacy left by the ancestors for celebrations of various social and cultural events and festivals.

v. Sonegaon: This is the oldest one and a 300-year-old heritage structure owned by Bhonslas. But it is the smallest of all the lakes under context and spread over 16.42 hectares of land. Sonegaon lake is situated in one of the major residential zones of the city. The Sonegaon lake is having a temple on one side and many people through temple trash nearby it. Another two sides are surrounded by roadway and the remaining one side is fenced by frozen soil.

This lake lacking in vegetation cover, are used only during morning and evening times. The absence of children's play equipment at Lake results in a lesser number of families visiting the place.

Sonegoanlake does not seem to attract the visitors in terms of imageability due to haphazard skyline formed due to low rise buildings in the periphery. Even its small size with less amount of water seems to be perceived negatively by the visitors.

The historic Ganesh and Hanuman temple at Sonegaon lakefront narrate and support the local cultural legacy left by the ancestors. Though traditionally these temples were used as worship places, now they serve various other purposes also like serving as meeting and interaction places particularly for elderly and women and stages for celebrations of various social and cultural events and festivals

vi. Sakkardara: This was built in the 18th century, during the Bhonsale's rule in Eastern Nagpur with area of 3.68 hectares. The beautiful Sakkardara Garden on the shore of Sakkaradara Lake is the favorite weekend spot of the locals as this lake is containing various kinds of plants water lily, Lotus. Two side of that lake is encircled by frozen soil, while one side is connected to the roadside. Alongside this road the Laxmi Narayan Temple have a heritage value.

vii. Pandhrabodi: The lake is situated at western side of city with area of 3.30 hectares. A lake situated adjacent to Ram nagar. The lake will be confined to northern side while south side remains a garden and lawn tennis ground.

viii. Naik Talao: The lake is situated at North-East side of city in residential zone with area of 3.0 hectares.

ix. Lendi Talao: The lake is situated at North-East side of city in residential zone with area of 2.6 hectares.

- x. Police Line Takli: The lake is situated at North side of city in residential zone with area of 2.02 hectares.
- xi. Binaki Mangalwari: The lake is situated at North-East side of city in residential zone with area of 1.21 hectares.

All the lakes except Gorewada serve as sites for celebrating social festivals like Ganesh and Durga Visarjan. Though actual immersion of idols in lakes is banned now looking at the environmental concerns, artificial lakes are formed at the banks of lakes for idol immersion. The lakefronts get flooded by families and social groups that involve themselves in various rituals and celebrate the festival enthusiastically.

Interestingly, no lakefront is having the provision of boating though, given a chance, people showed a preference for such recreational activities and would like to enjoy such facilities.

5. Today's Condition of the lakes? :

Unfortunately, the approach towards these water bodies has changed today due to technological advancements and changing lifestyles as people are looking towards other sources of recreation. Moreover, presently these lakes serve as mere elements of the city since the water supply is augmented from other sources located outside the city limits. If the lakefronts are maintained and improved, they could act as centers of recreational and religious importance as they have done it since historic times and can cater to the ever-increasing demand for recreation and entertainment with increasing population. This would also help these lakes to be socially acceptable and taken care of by the citizens themselves.

Stakeholder consultations have revealed that some of the lakes have been filled for development purposes. In some cases, slums have expanded into the lake areas. This not only leads to lake degradation but also poses a threat to the slum population.

These lakes are mainly used for recreational activities besides being exploited by unprecedented anthropogenic activities. On the banks of these lakes, slum settlements are located, and the habitants are seen using the readily available lake water for washing, bathing, for dumping trash and other domestic activities. The water quality of lakes were monitored by CSIR-NEERI, which shows the pollution in lakes. Water bodies are polluted and contaminated by various ways, leading to difficulty for survival of the flora and fauna and affecting the biodiversity of the city.

Nagpur city has lost two of its precious water-bodies in a span of 15 years, officially- Sanjay Nagar Talao and Dobe Talao- which existed in 2007, to vanish in 2022 due to encroachment from informal settlement.

Factually, many other water-bodies in the city are under the evil eye of land-grabbers and people with suspect intentions. Right at this current moment, the tiny lakes such as Lendi Talao, the Pandhrabodi (Ram Nagar) Talao, the Binaki Mangalwari Talao, the Police Line Takli Talao, the Naik Talao, Sakkardara Talao are under the threat of extinction. There also is an invasion of bigger lakes such as Telangkhedhi (Futala) and Sonegaon Lakes.



Figure 2: Gorewada lake



Figure 3: Gandhi Sagar lake



Figure 4: Sonegaon lake



Figure 5: Sakkardara lake



Figure 6: Police Line Takli Lake



Figure 7: Naik talao



Figure 8: Lendi Talao



Figure 9: Binaki mangalwari

6. Conservation and rejuvenation:

NMC's master plan for rejuvenation of water bodies also focused on the rejuvenation of the lakes in the city, which are considered as the heritage of the city. The rejuvenation project for Ambazari and Futala lake is under the implementation stage. It will ensure ground recharging of the water table, controlling the surface temperature of the areas nearby to the water bodies, and to some extent in preserving bio-diversity.

The Capital Investment Plan by NMC shows that Estimated cost for Rejuvenation of lakes in Nagpur city is Rs. 57.2 crores. Total investment for Rejuvenation of Lakes and Rivers (till 2041) will be Rs. 456.9 crores

The Conservation and rejuvenation of lake will be done as components like beautification, walkways, construction of RC embankment walls, abatement of non-point source of pollution, cleaning of water, construction of low cost sanitation, and lake front development and Awareness and IEC campaigns.

Rejuvenation of these lakes can aim at reconnecting the city residents with its water bodies through apt waterfront development and revitalization thereby giving the people an opportunity to interact with these water bodies and restore their faith in them through a holistic approach towards environment and planning.

Some beautification and recreational projects have been taken up for Ambazari and Futala lakes. Along with rejuvenation at Ambazari lake, the beautification is being done by making Swami Vivekananda Smarak, where people can spend their time. While Musical fountain show at Futala lake

with new seating arrangement will give the new look. Similar activities have been proposed for Gandhisagar, Sakkardara, and Naik Talao.

The lakes which lying neglected and contaminated for decades like Pandhrabodi, Lendi Talao, Police Line Takli and Binaki Mangalwari got the approval from Nagpur Municipal Corporation (NMC) for rejuvenation works for conservation of the lake. This lake are all set to be rejuvenated using concepts of National Environmental Engineering Research Institute (Neeri).



Figure 10: Nagpur Lakes in News



Figure 11: Swami Vivekananda Smarak, at Ambazari lake



Figure 12: Musical fountain show at Futala lake with new seating arrangement

7. Possibility of PPP

NMC can explore the option of rejuvenation of natural features by inviting private corporates to adopt lakes and rivers under their framework of corporate social responsibility (CSR). For attracting and to

motivate private corporate to participate NMC can organise annual awards for the best private corporate on basis of their efforts towards maintaining the water body.

8. Conclusion

The movement pattern of people is generally governed by design qualities and amenities provided in the space which could be understood by recording the behavioral pattern along with character and types of activities carried out in the space by the users. This can assist in understanding the lake features which enhance peoples' activities and use of space catering to the specific type and the group of users. Addressing these deficiencies and making necessary provisions in terms of design can help in making the space more conducive for different user groups and during different days and times of the day. It is generally observed that people prefer design interventions that promote proximity to the water. Hence design elements that bring them in close proximity to water should be provided.

The urban lakes are important in maintaining the surface and ground water balance, in maintaining urban ecosystem apart from its uses for different purposes namely recreational, water supply, fishing etc. Deterioration of lake water is also responsible for public health problems in surrounding area. Therefore, regular monitoring of lake water quality & lake ecosystem is necessary for taking appropriate environmental measures to protect & conserve lake water quality suitable for urban ecosystem.

People are sensitive to ugly and irresponsible designs. Hence unplanned, neglected or non-maintained features including natural and manmade are the least preferred. Consequently, planners and designers must strive for maintaining and upgrading the treatment of the edge of the lakes. Biodiversity plays an important role in enhancing people's satisfaction with urban lakefront environments since observing and experiencing flora and fauna in the form of green cover, wildlife, avifauna, etc. are highly valued motives of visiting lakefront spaces amongst the public. People like to be in the presence of nature and want to experience nature and bio-diversity present around. Accordingly, design interventions that support and are in harmony with nature should only be implemented like land erosion should be controlled by bringing more area of catchment under plantation, deepening the shallow areas of lake would control the weed growth in lake, desludging operations during lean period of summer season would be helpful to remove the accumulated pollutants in the lake.

The deliberate attempt of making people involve in active as well as passive engagements through provisions like outdoor gymnasium, kids play equipment and appropriate seating arrangements will help in providing opportunities for exercising, playing, interacting and chatting thereby enhancing the sense of cohesiveness.

Lakefronts should be acknowledged as landscapes comprising of natural and cultural components. Hence heritage structures at lakefronts should be conserved as they play a significant role in promoting local history, serving as a stage for celebrating festivals and cultural events and raising awareness regarding city heritage amongst local communities thereby reinforcing social and cultural connection amongst residents. Hence there is an urgent need to examine the interrelationship between present developments at lakefronts and people's perception and expectations about such developments.

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Mitigation of heat island effect through passive cooling techniques – case of Chennai city

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Abstract: One-third of the world's population will reside in areas with mean annual temperatures of over 29°C by 2070, which is significantly higher than the average temperature for the most of human history. The effects of rising temperatures will be seen in nearly every element of urban life, including human health and economic output. We urgently need technical and legislative solutions for cooling our cities and helping citizens adapt to rising temperatures. The automobile-dependent city's structure has significantly impacted people's daily social lives and outdoor thermal comfort as a result of Tamil Nadu's capital city's explosive growth. Reducing induced urban heat gain and enhancing outdoor thermal comfort are two of the most challenging tasks for tropical wet and dry cities. The main objective of the study is to examine ambient air temperature and humidity in various city locations and, using statistical analysis and heat index approaches, to pinpoint the city's most vulnerable thermal hotspots and simulating with passive cooling techniques to lessen the impact of the urban heat island and enhance thermal comfort. Since there are numerous types of UHI, including air UHI (UCL UHI and UBL UHI), surface UHI, and subsurface UHI, this study concentrates on UCL UHI. There are other factors that affect the development of UHI; however, this paper primarily focuses on the most crucial ones, such as vegetation cover and material surface reflectivity, because other elements, such as location, population density, and city size, necessitate long-term planning. The goal of this study is to familiarize experts with the concept of metropolitan intensity and explain why it serves as an important "focal point" for assessing and addressing strength and manageability in urban communities. It also aims to present specific specialized solutions for detached metropolitan cooling and develop an understanding of how they operate, their benefits and costs, and application considerations. This would also spur the adoption of urban cooling strategies through a multi-partner, all-encompassing development strategy.

Keywords: Heat Index, Thermal comfort, Passive cooling, Metropolitan Intensity.

1. Introduction :

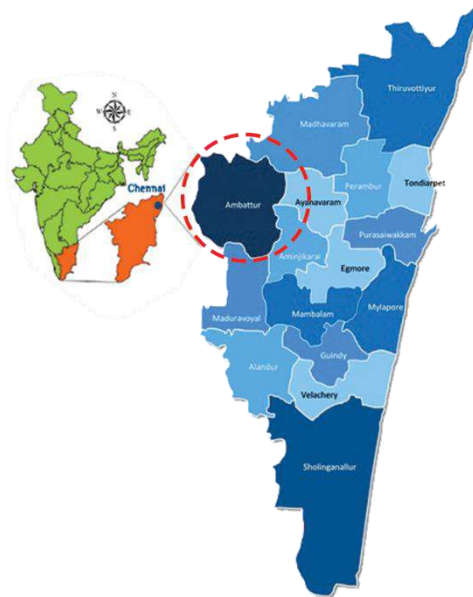
The peri-urban intensity island is made by the centralization of human action in peri-urban regions, which frames an "island" of intensity encompassed by an "ocean" of cooler rustic regions ". The trademark warmth of a town or city is known as a peri-urban intensity island, and it could be found in urban communities of all environment zones. The intensity island is characterized by Oke (1995) as "temperature varieties among peri-urban and rustic stations". "Human modifications of the surface and environmental elements, as well as peri-urban turn of events, cause accidental environmental change in peri-urban locales.

Thus, further developing the peri-urban climate's quality turns into a significant need. Quick urbanization has brought about various crucial changes in people, society, and the climate wherein we

1.1 Need for the Study :

Additionally, the places of the metropolitan poor are not adequately adjusted to the environment and are delicate to metropolitan warming. Hence, this examination work takes a gander at the improvement of outside warm solace conditions, through an investigation of the climatic effect of urbanization in Ambattur peri-urban area of Chennai City.

The Chennai Metropolis lies somewhere in the range of 12°50'49"N and 13°17'24" N scope and 79°59'53"E and 80°20'12" E longitude, along the south eastern bank of India, addressing the warm muggy sort of heat and humidity (Figure 1).It is situated on a level waterfront plain with a typical height of 6m above ocean level. The overwhelming breeze headings are from the southeast and northwest bearings.



The normal month to month relative moistness goes from 63% (June) to 80% (November) and the fume pressure shifts somewhere in the range of 22.6hpa and 32hpa. Figure 2 shows the temperature and precipitation examples of Chennai.

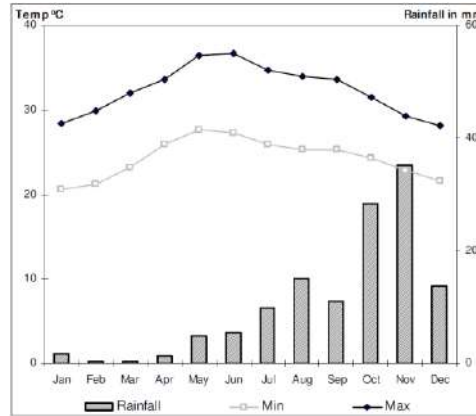


Figure 2: The mean maximum & minimum temperatures and rainfall in Chennai

Source: IMD (2020-2021)

The metropolitan construction in Ambattur area past as far as possible was overwhelmed by low ascent structures (one to two stories), yet is currently moving towards medium (three to four stories) and multi-story structures (up to 60m in level) to deal with the extra tension (CMDA 2008). Urbanization constrains the execution of land use changes, as displayed in Table 1.

Table 1: Land-use zones of Ambattur area.

S.No	Land use	Existing land use – 2006 in (%)	Proposed land use - 2026 in (%)
1	Primary residential	26.53	31.38
2	Mixed residential		13.51
3	Commercial	1.34	1.35
4	Industrial	6.12	6.76
5	Special and Hazardous Industrial		3.01
6	Institutional	5.23	5.73
7	Open space & Recreation	0.46	1.18
8	Agricultural	10.29	6.19
9	Non-urban	2.06	2.07
10	Urbanisable	-	1.76
11	Others (roads, waterbodies, hills, redhills catchment area, forests etc.,)	47.97	27.06

1.3 Objectives of the Study :

To grasp the idea of Urban Heat Island (UHI), its sorts, causes/influences and to decide the consequences for a peri-urban scale in a city. To evaluate the surrounding air temperature and moistness in various areas of the city utilizing remote detecting and to do measurable examination utilizing heat file draws near. To distinguish the potential reasons for UHI in Ambattur region and to research the seriousness and effect of UHI on the natural states of the locality. To investigate and foster different possible measures/models that could be executed to relieve the UHI impacts in study area.

1.4 Scope & Limitations of the Study :

As there are various sorts of UHI include: Air UHI (UCL UHI and UBL UHI), Surface UHI, and Sub-surface UHI, this exploration focuses on UCL UHI. Since there are many variables which add to frame UHI, this paper just picks the critical elements, vegetation covers, surface reflectivity and porousness and albedo materials, on the grounds that different factors, for example, area, the size of the populace and city, thickness and such require long haul arranging.

Then, in next stage, it fosters a model with the title of "Natural Ventilator of the City" (NVC). This examination primarily centres to situate professionals to the idea of metropolitan intensity and why it is a significant "focal point" through which to evaluate and address strength and manageability in urban areas, to feature the particular specialized answers for work with detached metropolitan cooling and work on comprehension of how they work, their advantages and expenses, and contemplations for use.

And furthermore this will empower the reception of metropolitan cooling arrangements through a comprehensive, multi-partner advancement process.

2. Urban Climate :

The environment in metropolitan regions is characterized into three scales, to be specific, the miniature size, neighborhood scale, and the meso scale, in view of their even and vertical degree as displayed in Figure 3.

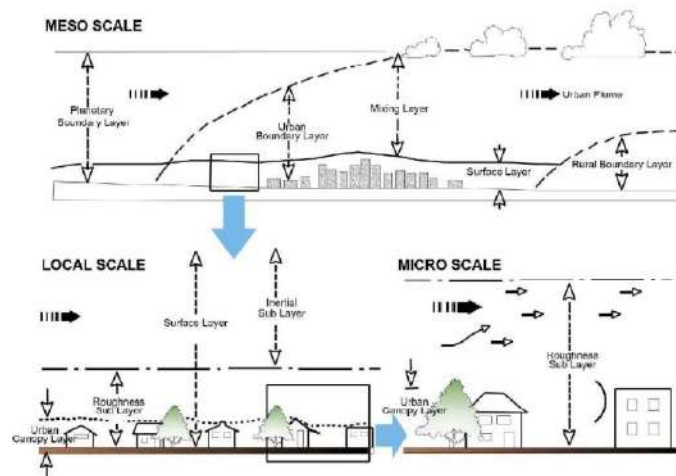


Figure 3: Climatic scales in urban areas

Source: Oke (2006)

2.1 Urban Geometry & Heat Island effect :

Oke (2008) states that the pace of cooling of metropolitan regions at the miniature level relies upon two boundaries of the metropolitan construction:

- Level - width proportion (H/W, road math) - the proportion of ordinary level of the structures to regular width of the adjoining roads.
- The sky view factor - the negligible part of the sky side of the equator noticeable from an area at the road level in a limitlessly long metropolitan road gulch.

Todhunter (2010) makes sense of that at the metropolitan gorge layer (UCL), metropolitan calculation assumes a significant part in characterizing the spatial and fleeting conveyance of the UHI contrasted with surface materials. In like manner, Arnfield (2011) thought about the impacts of metropolitan calculation and warm properties of the metropolitan texture and distinguished the accompanying:

- Gully calculation is the dominating component that causes variety in night-time cooling which brings about the arrangement of the UHI.
- The warm properties of the materials utilized in the metropolitan texture improve the distinctions in the cooling rates produced by the different metropolitan calculations.
- Notwithstanding the warm properties of the metropolitan texture and metropolitan calculation, the thickness of the upward surface (mass) of the gorge additionally impacts night-time cooling, however isn't sufficiently predominant to kill the impacts of the other two.
- The presence of mists builds the sky emissivity, coming about in more vulnerable night time UHIs, subsequently lessening the distinctions between the different gully structures.

2.2 How to measure UHI:

"The climatic UHI and the surface UHI are connected, obviously, yet the cycles engaged with their beginning and transient elements are divergent. Without this appreciation, unrealistic to accommodate the perception surface intensity islands are frequently most prominent by day, while those in the air are biggest around evening time, and as a matter of fact, may try and be negative in the day". In this way, the beginning, processes and the extents of the different UHIs rely significantly upon the perception techniques took on.

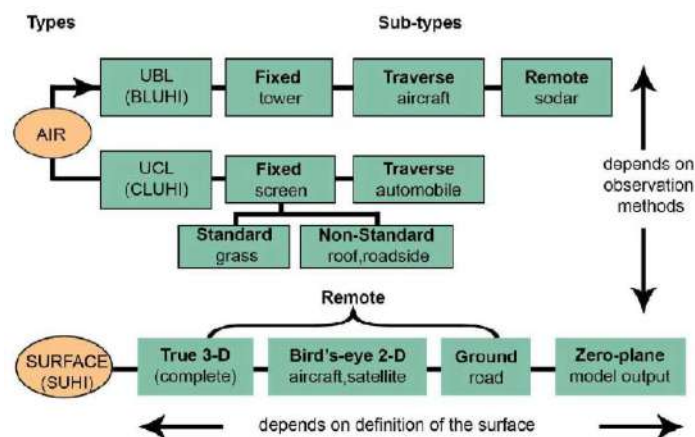


Figure 4: Measurement methods of UHI

Source: Oke (2006)

2.3 Passive Cooling Strategies:

Numerous nations have forced energy-saving arrangements on structures and studies zeroing in on lessening the natural impression of structures have arisen all over the planet as the need to diminish indoor temperatures, give solace, and safeguard weak populaces keep on expanding. Relief methodologies can be found in bioclimatic plan and endeavours ought to be coordinated towards learning and reincorporating these practices in the present engineering. The requirement for growing new items and advances, instructing planners, engineers, and the overall population to follow these standards is basic to get away from energysubordinate frameworks and establish environment adjusted structures with lower ecological effects. It is essential to reconsider the standards of

bioclimatic engineering and its many advantages and comprehend the advancement of private cooling and the warm solace assumptions and guidelines which have mixed planners from bioclimatic plan.

2.4 Warm Comfort:

Warm solace can be characterized as a state of psyche communicating fulfilment with the warm climate in which an individual doesn't like to be hotter or cooler. Holopainen et al. make sense of what human warm sensation is meant for by outside boundaries like air temperature, air speed, and moistness, yet additionally by inward boundaries, for example, metabolic rate, movement level, and dress. The present guidelines and assumptions direct specific degrees of solace in boundaries like air temperature, air speed, and mugginess, notwithstanding, more adaptable temperatures could bring about better tenant fulfilment and more maintainable practices. Hence, it is appropriate to address and challenge the ongoing solace boundaries directed by guideline. Taking into account a more extensive and more adaptable scope of warm solace boundaries coordinated with detached plan techniques could assist with further developing solace levels while lessening structures' energy loads for warming and cooling.

These reaches can be broke down in bioclimatic graphs which are utilized to decide warm solace levels as they present on a psychometric diagram the blend of temperature and dampness given a particular climatic qualities. Victor Olgyay fostered the most generally utilized outline which was taken on by ASHRAE, and in view of similar boundaries, has been utilized and created in various examinations. For instance, Manzano-Agugliaro et al. (2015) adjusted Givoni's outline (Figure 5) consolidating the different climatic zones for which it is important to utilize systems to arrive at warm solace levels, giving rules to various inactive plan techniques. This device can work with the examination of the climatic states of a given area following warm solace and guide a structure's plan so it's better adjusted to its current circumstance, and hence can be utilized to direct latent cooling methodologies.

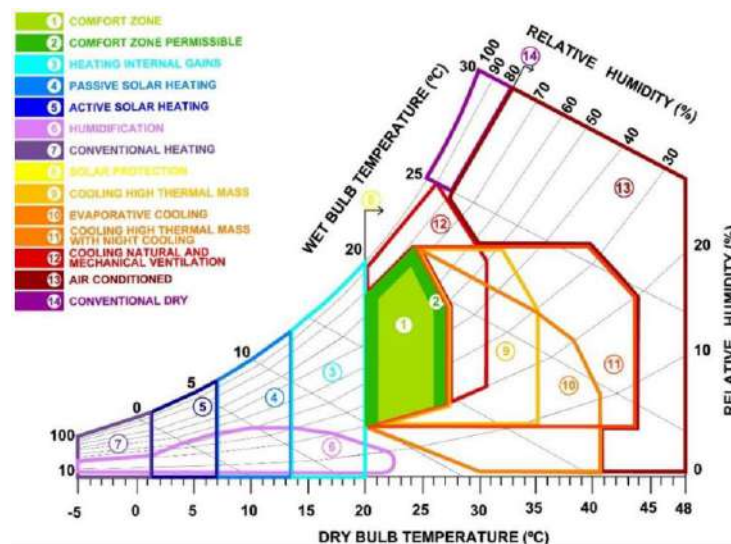


Figure 5: Psychometric chart

Source: Manzano-Agugliaro, Montoya, Sabio-Ortega, & García- Cruz, 2015

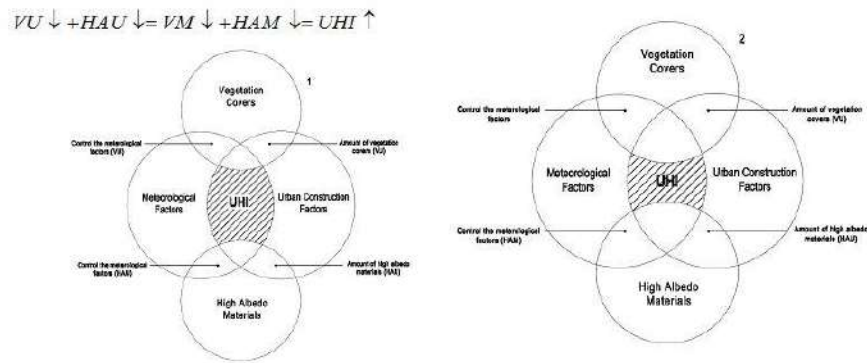


Figure 8: Increasing the amount of greenery & high albedo materials mitigates UHI effects

3. Methodology :

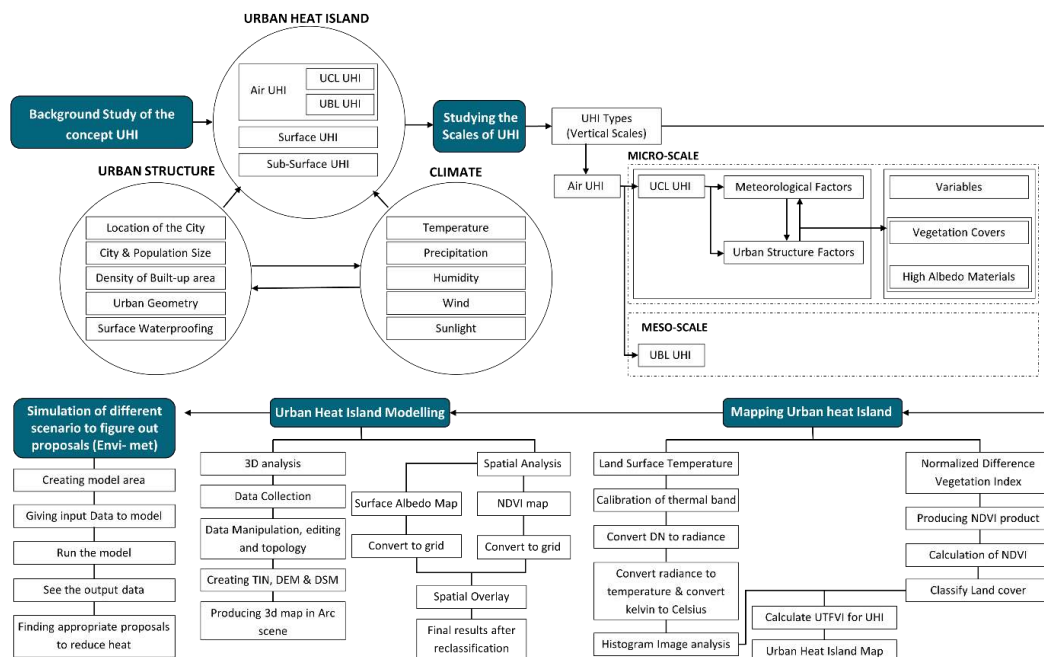


Figure 9: Research framework of the study

The spellbinding techniques are taken on to comprehend the effects of urbanization on microclimate through an investigation of the time series information got from the weather conditions stations and the satellite symbolisms. The trial strategies include field estimations of environment factors from fixed areas and vehicle navigates (versatile study). These field estimations are utilized to plan the temperature varieties in the review region, and to break down the causal connection between the metropolitan assembled climate and warm solace conditions. The information got from the elucidating and exploratory strategies are handled and dissected through different programming like ArcGIS 10.4, ENVI 4.1 and RayMan Pro. The previously mentioned techniques are consolidated in various ways to achieve the goals of the examination and are illustrated in Figure 9.

4. UHI Modelling :

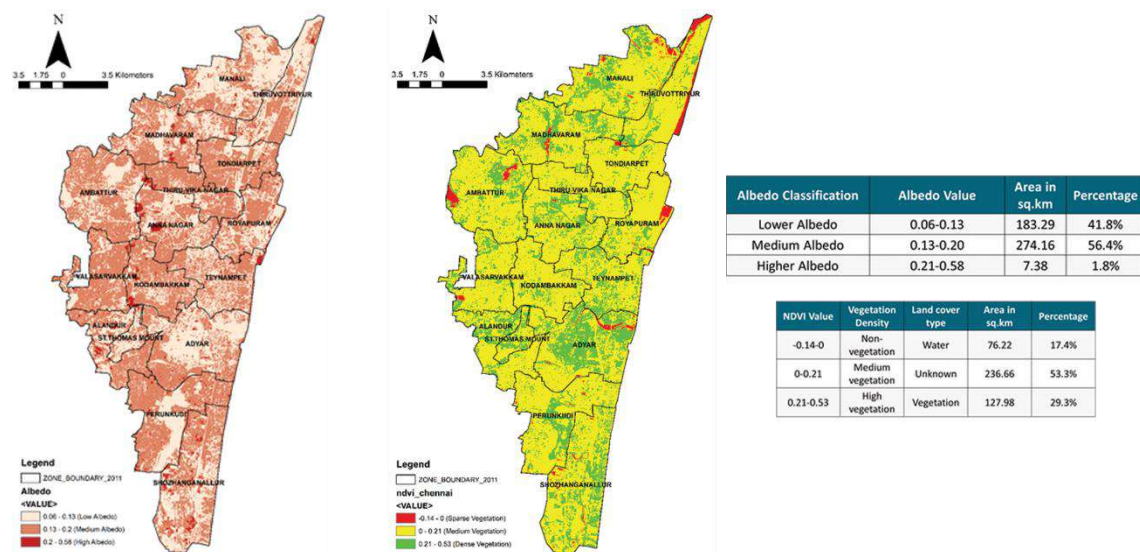


Figure 10: Results acquired from making albedo and NDVI lattice maps

4.1 NVC Model:

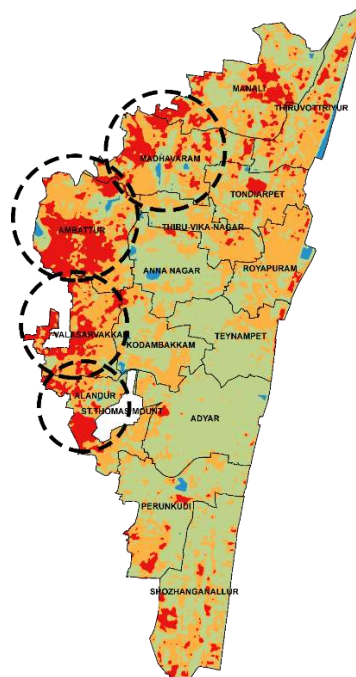


Figure 11: Overlay of Surface albedo and NDVI to indicate the thermal hotspots

4.2 Area for Simulation of NVC:

The model regions were made with the assistance of format plans, ethereal pictures and photographs taken nearby. The design plans were utilized to characterize the layouts and level of the structures. As these design plans were somewhat obsolete more current structures were made by just utilizing the data acquired from airborne photographs and photographs taken nearby. These photographs were additionally used to demonstrate the ground surface and the vegetation inside the quarters. The mistakes made by utilizing this somewhat incorrect strategy for digitalization are accepted to be more

modest than the model goal of >2m. The variant of ENVI-met utilized for these reenactments is restricted to around 3 million matrix cells. The vertical and flat goal of the model network was set to the littlest potential qualities permitted by this imperative.



Figure 12: Model area for NVC

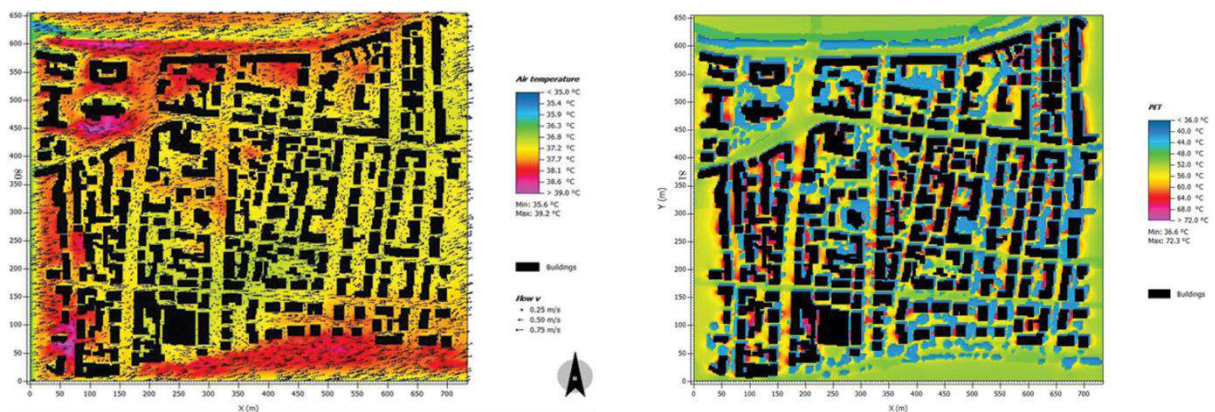


Figure 13: Air temperature & wind speed during day & night at 1.5m above GL

4.3 Simulation of Scenarios on a Neighbourhood Level and the Results:

This recreation analyzes what is happening of Chennai city with three situations as per the variable of the NVC model. These three situations will be made as follows: Situation 1: change of current low albedo material to high albedo materials; Situation 2: cover model region with vegetation cover; Situation 3: cover model region with vegetation cover alongside high albedo material.

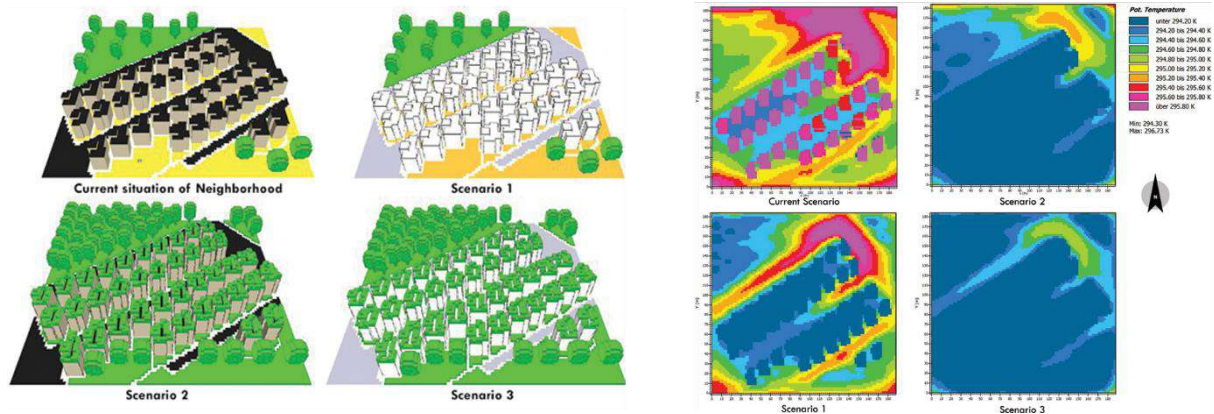


Figure 14: Results of Simulation

4.4 Conclusion:

In situation 3, the blend of vegetation and high albedo material has been analyzed to test that what these two factors can mean for the encompassing developed region in equal. As found in Figure 38, in situation 3, clearly the blend of these two factors can influence to diminish the temperature around 2.43°C. Situations' 1 and 2 additionally add to lessen the temperature separately, while in situation 3 which is the mix of situation 1 and 2 has outrageous commitment to relieve the air temperature. Subsequently, in the cross-examination of the three situations for temperature, the best cooling impact on the encompassing developed region is seen in the third situation and cooling impact of vegetation alongside high albedo material can be affirmed by the recreation.

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MANAGEMENT OF URBAN LAKES IN INDIA

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Abstract : Urban lakes was defined by the National Lake conservation Plan(NLCP) in 2008, that a water body which has depth more than or equal to 10M and size must be equal to or more than 3 hectare consider as urban lakes. Other guidelines given by the Ministry of Environment and Forest (MOEF) for the protection and conservation of the urban lakes. Despite of lot of action and planning policies, the condition of urban lakes remain same. The aim of this research paper highlights the challenges faced by the urban lakes and study different model used by the different cities municipal for protection of urban lakes. The case study methodology opted for this research. This research paper is the review of the other research paper and policies and articles.

Keywords: Urban Lakes, Lakes in India, Urban Planning

1. Introduction :

The urban lakes was defined by the National lake conservation plan (NLCP) in 2008, that a water body which has depth more than or equal to 10M and size must be equal to or more than 3hectare consider as urban lakes(Report MoEF,2013). It has some aquatic ecosystem also. The NLCP body responsible for conservation and protection of lakes since 2001, under Ministry of Enviroment and forest (MoEF). Later the body was merge with National wetlands conservation programe (NWCP) in 2013 and make a new body which have charge for protection and conservation of existing wetlands and lakes. But the guidelines remain the same. The total number of lakes consider under this programme was 62 lakes in India from the different states and region. The NLCP highlights the issues of the fund and practically not feasible for all the lakes in India. The selection criteria are based on the other perimeter are:

1.1 Hydrological criteria :

The lake water body should be perennial. It should hold certain amount of water through out the year, even in the time of summer (Report-MoEF, 2013).

1.2 Scientific criteria:

The lake water quality should be matter of concern by the state government or the water quality of the lake is highly degraded because of discharge of sewage, waste water and industrial waste. Lake is treated more like a dumping ground for the solid waste can be consider under the programme (Report-MoEF, 2013). The refrence for the surface water quality of the lake is consider as the bathing level water quality by CPCB(Central Pollution Control Board).

Fecal coliform	Desirable : 500MPN/100ml Maximum: 2500MPN/100ml
Fecal Streptococci	Desirable : 100 MPN/100 ml Maximum: 500 MPN/100ml
pH	Between 6.5 and 8.5
Dissolved Oxygen	5 mg/l or more
Biological Oxygen Demand(3 days)	3 mg/l or less

Table 1: Water Quality for outdoor bathing(CPCB)

1.3 Administrative Criteria:

1.3.1 If lake water quality degraded or eutrophied although the main purpose of the lake water is for drinking water supply, domestic use and recreational use.

1.3.2 Lake categorized as a “unique fresh water ecosystem” (Report-MoEF,2013).

2. Purpose of Urban Lakes : The urban lakes are not only the source of water, but it help to maintain the temperature of the city by reducing urban heat island effect. It also mitigate the effect of flood in any city. Its biological production provide food for the humans, for example; fishes, crab. It help to recharge the ground water table, which is the main source of drinking water in Indian cities. Urban lakes are also responsible for the socio-cultural space in any city. The lake font development programme run by different municipal in different states. Some are the example of the best model for the human settlements.

3. Statement of the Problem: The NLCP (National Lake Conservation Programme) programme mention only 62 lakes as an urban lakes. Some cities are totally ignore for example Pune city, Katraj lake, Pashan lake which comes under this criteria. The definition for urban lake is not complete, some lakes are dried during summer season and the water availability during this season is below the standard mention in the statement of urban lakes. The authorities more focus over the money related issues and the beautification of the lakes. As per the NLCP development statement for the urban lakes the 25% area should be developed for the human interaction and socio- cultural or recreational space (MoEF Report, 2013). There is no clarity by the authority over this proposal. The buffer zone around the urban lakes are not clearly specify by the NLCP (National lake conservation Programme) although the National Green tribunal Act implement the guideline for Karnataka state that the buffer zone around the urban lake must be 75m. No construction are recommended in this region. Later the act was

challenged by the local builder groups in Supreme Court and buffer zone limit set as 30m around the urban lakes (The Economic times, 2019).

- 4. National Status of Urban Lake in India:** Most of the lakes in India are man-made and natural. They found in different states of the degradation level. The watershed degradation is the most important cause of the degradation in lakes. In rural areas the intensive agriculture and deforestation is main reason for the watershed degradation and in urban areas, the urban and industrial activities in catchment area. The most important and common form of lake degradation is that deterioration of water quality due to organic pollution from disposal of domestic waste water and other solid wastes. Eutrophication (enrichment with nutrients) is another major and most widespread problem in maximum lakes. The eutrophication process reduce the oxygen level of the lake water and increase the other chemical substance in water, which results dangerous for aquatic animals and plants. The eutrophication of the lake is a natural process. It is the indication of ageing of the lake, normally this process take long time. But in urban region because of the water pollution and surface pollution started early. To improve the condition of the urban lakes, different model and practices advice by the authority. The condition of the urban lakes in Indian cites and practices are given below:

4.1 Delhi urban lakes : As per the research 2010-11 to check the changes in the water bodies, the status of the 44 lakes was ascertained and the results found that the 21 lakes are already filled and dried because of urban activities (Singh et al., 2012). The other reason for the bad condition of the urban lakes are no clarity over the data and ignorance by the governance system. This case was highlighted by CSE (Center for Science and Environment) in 2008, where in 2001 on the order of High Court a joint survey committee assess the number of natural water bodies in Delhi and submitted the list of 508 water bodies, on the other hand TAPAS(Delhi based NGO) submitted the list of 794. Later DDA (Delhi Development Authority) submitted the list of 580 water bodies in 2004. This list was not matched with the NGO (Non-Government organization) TAPAS.

4.2 Bangalore city: The Lake Development Authority (LDA) of the Bangalore city still in process to develop a model for the Bellandur lake and Hebbur lake, where the approach was public participation (PPP). This model consider stakeholder is the important variable for the development. Under the stakeholder birds, flora, fauna and human all are considered (Chandrakth, 2018). As per the ECBC the Bangalore city comes under warm and dry region, because of the percentage of the urban lake reduced significantly(Chandrakth). The main reason for the dried of the urban lakes are the urbanization. The Bellandur lake, located in South Bangalore and covers 361.3 ha area and has the depth 5m. The main uses of water for the irrigation surrounded by villages. The lake reached at the level of eutrophication, high concentrate of nutrient promote excessive growth of algae. Municipal highlight the reason of degradation of this lake is entering sewage and industrial effluent without treatment. The BWSS (Bangalore Water Supply and Sewage) take the responsibilty for the diversion of sewage line. Bangalore was once known as „city of the lake“, but unfortunately since 1973 to 1996 the number of lakes are drastically reduced 379 lakes to 246 lakes respectively.

Presently only 81 lakes are present and majority of them are quite small (<10 ha) (MoEF Report, 2013).

4.3 Andhra Pradesh, Banjara Lake: The Banjara lake, also known as Hameed Khan Kunta is 80year old lake, which has 4.17ha size and 5.0m depth. The lake is surrounded by the Banjara hills in its west, small group of apartments complex in its north, some slums on west side and Taj Banjara Hotel at South. The eutrophication started at the surface of the lake water because of the disposal of the sewage from the existing apartment side. The Andhra Pradesh Tourism Development corporation Ltd (APTDC) in association with Taj GVK, has developed a conservation and mangement plan. The measure takes to improve the condition of lake water are montoring and prevention of further pollution by treating the sewage entering the lake, lake aeration and other activites for improving its aesthetics (MoEF Report, 2013). The guidelines are not in details, what actions will be taken to imprpove its aesthetics and surface water.

4.4 Pune, Dhanori Lake: The Dhanori lake of Pune is not mention under the NLCP (National Lake Conservation Plan) declared list of urban lake. But as per the criteria, it should be comes under the urban lake. The Dhanori lake comes into the lime light in 2008, when the Lunkad Group of builders want to construct a business hub over it. The lake was surrounded by the residential quarter, small group of slums and other side is an internal road of the city. During the rainy season the lake water comes into the apartments. It has a small aquatic ecosystem. The existing lake is over the quarry, which was stopped at the order of collector in 1952 (Mishra, 2018). Now presently lake was a take care by PMC (Pune Municipal Cooporeation) and Tree watch NGO(Non Goverment Organization). The surface water quality is in good condition.

4.5 Ahmedabad city, Kankaria Lake: the other example of urban development around the lake is Kankaria Lake, Ahmedabad. It was developed for public recreational activities. This lake front model is considered the best example of urban spaces. However, it is not considered a good example of an approaching ecosystem. The model was criticized by the environmentalist that the concretizing of shoreline affects the flora and fauna of the lakes (Bahudre *et al.*, 2014). This project took 2 years for implementation. It was open in 2008 for public activities, after 2008, the siltation of the lake has started because of the urban activities (Bahudre *et al.*, 2014).

5. Conclusions :

5.1 The NLCP (National Lake Conservation Plan), did not covered all the aspects for the urban lake. The list of urban lake not be limited to the 62 lakes.

5.2 At state level monitoring body required to check the status of the lake at every 3 to 4 months period of the time. As the earlier research reflect that the percentage of the BOD and COD change as per the wheather and climatic condition changes. The increase in the percentage of BOD and COD is the indicator for the high pollution level (Pimple,2015).

5.3 Another body required to implement the different method for improving the water quality and quantity of the body. As per the MoEF report, 2013 the Government have limited fund and not all the lakes of Indian cities can be considered

5.4 The urban activities in lake catchment area must be in controlled manner and analyze the impact before implementing.

5.5 The buffer zone 75m for the urban lake should be declared by the state government and free from the urban activities. These guidelines are applicable only for Karnataka lakes by their municipal corporation NGT(National Green Tribunal),2016. Later in 2019 the act was challenged by the Karnataka Builder group at the Supreme Court change the buffer zone limit 75m to 30m ,which have adverse effect on Urban Lake (Kankumar, 2018).

5.6 The percentage of the phosphorus and Nitrate must be checked time to time (NLCP, 2008)

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Design of Shrines on confluences: Lessons for Contemporary Design

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Abstract: Traditionally Indian builders have chosen scenic riversides to place their shrines and monuments. Great importance was given to flowing water since it is believed to connect the earth and the heaven. Especially the sites of confluence of two rivers were revered a great deal. Often these sites naturally evoke awe and wonder along with appreciation of the natural beauty of the geological formation. The feelings were enhanced by placing the shrine at the spot. The value of these beautiful natural sites was increased manifold by placing beautiful temples and *ghat* (flight of steps leading to water) in them. Kings and queens, royal family members, nobles and wealthy patrons, sometimes even saints sponsored construction of temples and ghat at such places to earn good merit and immortality. Once constructed these temple precincts went on acquiring layers of history, culture and architecture through regular use by common public for religious, recreational as well as spiritual pursuits. They also influenced the human settlements in surrounding region. There are great learnings for modern architects, urban and landscape designers from these places which deserve detailed study and analysis. The studies of culture, history and socio-religious importance of important confluence sites are written, however very little documentation and analysis of architectural form and design of confluence sites exists in public domain. This paper selects three lesser studied confluence shrines for discussing various factors such as physical and cultural context, connection with the community, location, approach, visibility, planning, orientation, form and details, the response to the physical and cultural context, and sensitivity about the environment. It uses observations from site visits, photo documentation and analysis as primary research method and uses secondary data for understanding historicity and antiquity. The design of these sites fulfils all the modern expectations of appropriate design embedded in nature, environment, community and culture.

Keywords: River Confluence Shrines, Ghat, Traditional Design Wisdom, Cultural Influence, Lessons of planning and design

1. Introduction : River confluences: Nature and culture

Since ancient times Indian people have considered rivers as sacred. Rivers are the sources of clean water which is a daily necessity. Rivers are purifiers, life givers, and even holy carriers of mortal remains. They are connections between earth and heaven. Scholars have noted that the confluence of rivers is considered more sacred by pilgrims as these points have a sort of cumulative sacredness. The pilgrims can earn good merit (Punya) twice by bathing in two rivers at the same time (Letizia, 2017). Ancient Indian temple builders have often picked up the spots of geological events such as confluences to place their temples. The site's natural beauty is enhanced by placing the architecture in the geo-cultural context. The religiosity, the mythology surrounding the temples and the architecture enhancing the natural context add layers of complexity around the confluence site to make it totally irresistible to the pilgrim.

A simple riverside shrine becomes a 'teerthkshetra' only when nature, culture, history, religion, patronage, and architecture merge into one another enhancing each other. The temple complexes not only connect the community, nature and religion but also display sensitivity to history, memory, and culture. These places have kept alive the connection between human, nature and divine through annual staging out of rituals and festivals despite the political upheavals and economic undulations.

There are many lessons to be learnt by any modern architect-designer from historic confluence sites. The designers of the ancient sites have won half the battle by selecting the site overlooking the confluence. The other half is won by generations of designers contributing to the place-making. Sensitive consideration of sight lines, contour lines and the selection of architectural form fill us with wonder. This paper explores three sites to analyse the aspects which appeal to mind and intellect in an attempt to decode their magic and popularity. The report begins with a literature review and then sets out the research problem. The background and context of the case studies is put forth initially and then the design is discussed in detail. The design aspects are analysed to finally enumerate the learnings.

2. Literature review: Understanding the magic of riverside architecture.

Here is a brief summary of important themes from a plethora of literature about sites at the interface of water and religion. Rana P B Singh has researched and written extensively about Varanasi, one of the great ancient sites of water-religion interface. He attributes the appeal of a riverside religious precinct to three aspects. The unique natural landscape and beauty, the unusual physical features of the water-body and the mythological stories associated with the place. Eighty-four ghats cover a length of 6.8km along the crescent-shaped bank of the River Ganga, from the confluence of Asi drain in the south to the confluence of the Varanā river in the north. Here the riverfront is marked by lofty palatial buildings built mostly by kings and lords from different parts of India between eighteenth and twentieth centuries, and the area along the Ghats is dominated by various shrines and temples (Singh et al 2003). Singh discusses the cultural and historical aspects in great detail and physical mapping of the riverfront structures is also done by Singh and his team and also many other scholars of architecture and culture. Landscape Architect and Historian Amita Sinha also explains how the urban design of the Ghats along the Ganges are sites of divine manifestation in the form of temples and deities and rituals of veneration. They have an ability to transform into spaces for performance of religious rituals that also create a spectacle for the visitors. The Ghats are specially designed for this function, or the Ganga Aartis are so staged as to use the design of Ghats as an open air theatre (Sinha, 2018). Dr Sinha also uses detailed documentation drawings to comment on the spatial practices, but does not comment on the design aspects of the Ghats, perhaps because it is already done by others elsewhere. Elizabeth Clarke in her masters thesis discusses the necessity of bringing together architecture- the object and the landscape in which it is situated- the subject for 'place making'. technology, abstraction, perception, aesthetics all contribute to experience of 'place'. According to Risko village communities of Uttarakhand engage with sacred springs in their landscape far more intimately than river Ganges. their relationship with the springs as the only source of drinking and cooking water makes them rever it and consider it sacred attributing it functional, ritualistic and spiritual value (Risko, 2018). though many authors discuss and record multitude of aspects of riverside and confluence sites, very few scholars such as Sinha are actually discussing formal aspects of riverside and confluence architecture in some depth. Numerous shrines spread over the entire india have remained in oblivion, necessitating a look at some of them.

3. Background and context, relevance

Modern technology has driven us to psychological detachment from nature in all its forms and treating it only as an object of exploitation. This has led to increasingly fragmented and disturbed society. Harmonious relationship within a community and its landscape is only possible through a confluence of physical and spiritual connection with nature (Clarke, 2012). Understanding how our ancestors used architecture and landscape to realize potential of perception and aesthetics, to open mind and spirit for the experience of poetic would be worthwhile in pursuit of interconnectedness of nature and community.

This study explores lesser known confluence shrines such as Nrusinh Temple Complex at Nira Narsingpur, Sangameshwar Temple at Saswad, both in Pune District and Sangameshwar and Harihareshwar Temples at Hattarsang Kudal in Solapur district with intentions described below.

3.1 Aim-

To understand the design aspects of lesser known ancient riverside shrines in Pune and Solapur region.

3.2 Objectives-

1. To map the shrines in terms of location, visibility, general plan and sections
2. To understand physical and cultural context of the shrine and the connection with the community
3. To analyse planning, orientation, form and details, the response to the physical and cultural context, and sensitivity about the environment.
4. To underline architectural achievement and cultural contribution and understand role of some common features.

3.3 Scope and limitations

The research only examines the siting of the temples, the connection of the building and the landscape and the connection of confluence point, placement of shrine and the settlement. It focuses on setting of the building in the landscape. The study does not describe or discuss the architectural form of the temples in detail. The research considers only three examples in Solapur and Pune region from varied historic era.

3.4 Research Methods

The research is an exploratory research as a precursor to a larger and deeper study. It depends on secondary data as well as primary data. It uses some basic methods such as mapping, photo analysis and architectural analysis based on multiple visits to the sites to generate primary data. Aspects such as historicity of the shrine, relation of shrine with the settlement, approach, planning, orientation, placement of shrine, relation with the riverbank, cultural –historical importance are discussed to find clues to the planning decisions. Comparison purely of the physical and experiential aspects is made to generate conclusions.

4. Discussion and analysis

4.1 Case I- Nrusinh Temple Complex at Nira Narsingpur

Nrusinh Temple Complex at Nira Narsingpur stands at the confluence of Nira and Bhima Rivers. Nira originates in Western Ghats, flows through Pune, Satara and Solapur districts and meets the Bhima at Nira Nrusinhpur. Bhima is a major river of western India, originates in Western Ghats and flows a long route of 861 km irrigating regions of Maharashtra, Karnataka and Telangana states.

The shrine has great antiquity as a holy place, it is believed that this is the center of the earth, its 'Naabhisthan' (naval). Devotees believe that Shri Ramchandra and Maharshi Vyas visited and performed rituals here. In medieval times saint poet Samarth Ramdas visited and preached here in *Shake* 1553(1631CE). The oval shaped *ghat* (flight of steps leading to the riverbank) at the site of confluence was built by Trimalpal Dadhoji Mudhoji in *Shake* 1527 (1605CE). The work went on continuously for three years. The temple was restored by Ragnathrav Vinchurkar in *Shake* 1787(1865CE) (narsingpur.in). It is clear that the shrine has developed over hundreds, if not thousands of years as a place of worship, but the existing ghat and temple form which has a beautiful and powerful design was constructed in 17th and 19th CE respectively. Before 20th CE and prior to construction of modern bridges, the island like land between the two rivers would have been accessible only through boats. possibly the settlement was limited to some area in the close vicinity of the temple on the V shaped land formation, that too of people connected with or dependent on the temple for their livelihood. The devotees also may have approached through other land routes or by crossing rivers on either side by boats. However after the construction of bridge on south in 20th CE the settlement spread on the southern bank of Nira River.

The approach to the tip of the V shaped land between the converging rivers is from southern bridge. The temple is aligned on east west access, the deity facing west, with its back towards the confluence point and facing the settlement in front. The ghat on east, at the back of the temple gradually descends to the confluence point, has beautiful stone elephants and other animals guarding the high steps. The southern bank also has stone steps forming various terraces for bathing and performing religious rituals. The view of the ghats on southern and eastern bank is the first breath-taking sight while approaching from southern bridge. The temple wall and front bastions soar about 30 m above level of the river, thus securing it from floods. The temple is constructed/ restored in Maratha style, even if the temple probably existed since Yadava times.



Figure 1: Temple Entrance Nira Narsingpur Figure 2: Confluence tip at Nira Narsingpur

Ghats perform dual function of protecting the land from erosion by the strong water currents and making the confluence point accessible to pilgrims with safety. The use of black basalt stones local to this region, interlocking joinery and use of lime mortar have made this a durable structure. Especially the ghats on north, east and south have protected this tip of land from washing away by the forceful current of monsoon discharge. The ghats have retained the original topography of land, only slightly modified it by creating terraces, pause points which provide open flat areas for performing rituals by the edge of river and for making it easily scalable for people of all ages. Thus functionality, beauty and strength are achieved by the design.



Figure 3: East Ghat steps have animal figures

Figure 4: South ghat has multiple terraces

However once inside the temple enclosure of the rivers on both sides is hidden from view, thus denying the pilgrims the visual pleasure of the flowing water and cool currents. One must come out of the back

door (on east) of the temple precinct and walk some distance towards east, to perceive the rivers on both sides. One must walk further and climb down the steps of the ghat to reach the flowing water. This is perhaps for the security of pilgrims, or for underlining the importance of physical experience over visual pleasure as a medium of attaining a spiritual experience. Performing a religious ritual at the holy confluence was considered more important than enjoying the beauty of the wonderful natural event of the confluence. Still the powerful form of the ghats facilitates the experience of poetic feelings especially at dawn and dusk.

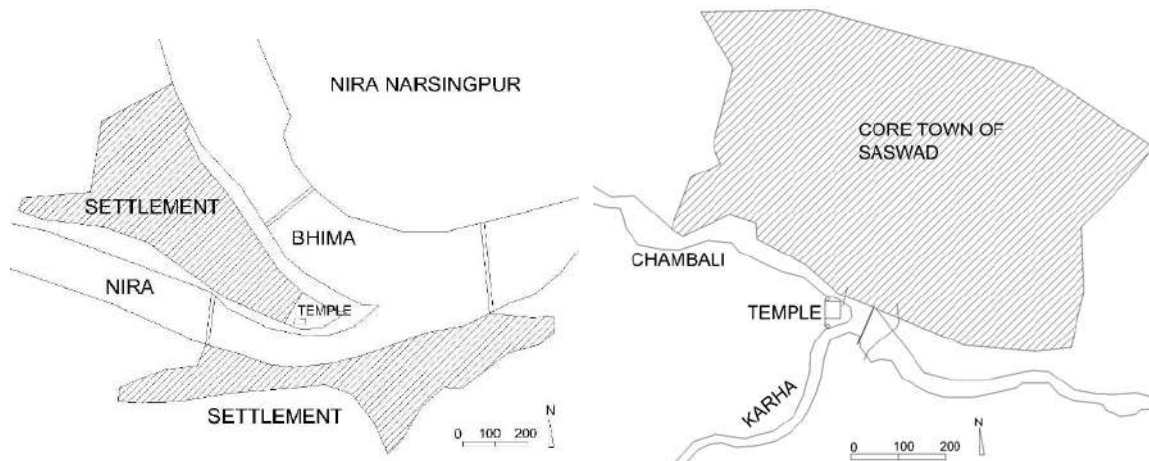


Figure 5: Relationship between temple, confluence site and settlement: Nira Narsingpur and Saswad

4.2 Case II - Sangameshwar Temple at Saswad

Sangameshwar Temple at Saswad stands at the confluence of Karha and Charanawati (Bhogawati, Chambli) Rivers. Both originate in nearby section of Western Ghat, the Chaturmukh Hill. Karha originates near Varwadi and Garade Village, flows to Saswad, Jejuri, Pandeshwar, Morgaon, and Baramati and meets Nira River at Songaon in Baramati Taluka. The birth of the river is attributed to an incidence in Mahabharata times (<https://youtu.be/6UrsrZfOGP0>), the modern river is dammed twice once near the very source at Garade and the other near Jejuri.



Figure 6: Confluence view at Saswad, Sangameshwar Temple is sitting at land tip surrounded by two rivers. The bund is in foreground while steel foot-over bridge is seen in right corner.

Though Saswad is well known for Sant Sopandev's (Sant Dnyaneshwar's younger brother and renowned spiritual personality of Varkari Sampradaya) memorial (13th CE), the temples, fortresses (Purandare Gadhi) and the ghats were built in 18th and 19th century by nobles of Peshva court. The Saswad town has developed entirely on the north bank of west-east flow of both rivers. Apart from a couple of ghats there is no connection of the settlement with river indicated by the introvert layout of the roads. When the Sangameshwar temple was constructed at the confluence point in 18th CE it only added another temple to the series of temples in the settlement, to be visited on special occasions such as Mahashivratri. It did not develop an everyday bond with the residents. The approach is by a modern foot-over bridge which lands the visitor on the lower terrace of the temple on north. Before it was constructed there probably was a stone foot-over bridge over the short distance, or boats were used to access the temple. There is a stone bund right in front of the temple at about 50 m across the widened width of the river after the confluence. This was probably built in British times.

Sangameshwar temple has ghats on north east and south, the confluence is on the east and the west has a straight stone boundary wall clearly indicating the end of the property. Beyond this wall the fields are stretched on the west. On the edge of this wall there are two similar and symmetrically placed subsidiary shrines on north as well as south which stand like sentinels on both sides of the temple. There is a wide landing which connects both these temple in a oval arc. Another landing at next level also skirts the main terrace of the temple. The temple is situated within this half oval on a square terrace. The level of this terrace from the water level is approximately 12-15m high. The form of the temple has successively increasing spires taking the viewer's eye from the river to the highest spire in an upward sweeping motion (see Figure 5). This is intentionally achieved by the designer to create an experience of elation, beauty forming the path of communion with divinity.

The orientation of the temple is exactly aligned to cardinal points, the deity faces the east, looking at the settlement spread in front. The original topography of the site is modified to make two lower terraces of equal height and the third and final terrace considerably raised. This has enhanced the overall setting, the temple sits in the site as perfectly as a jewel in its setting.



Figure 7: Sangameshwar Temple, seen from south east. Figure 8: the temple precinct seen from air

The design and detailing of the ghat is perfectly aligned to the micro-context of the site. It protects and beautifies the vulnerable tip of land just near the confluence. Smaller shrines, memorials and pilgrim's rest house is very well adjusted in overall scheme. The temple terrace offers a view of the surrounding landscape without any obstacle. Trees and shrubs associated with Shiva worship such as Plumeria, hibiscus and swastika are planted on the lower terraces. The scale and size of the confluence site and the temple are in perfect harmony. The overall setting and the architecture of the temple is so pleasing

that it distracts from the sense of devotion. The temple is majorly a site of recreational tourism in addition to pilgrimage.

4.3 Case III- Sangameshwar and Harihareshwar Temples at Hattarsang Kudal

Temple precinct at Hattarsang Kudal witness the confluence of Bhima and Sina Rivers on the south eastern border of Solapur District. Bhima originates at Bhimashankar in western Ghat, a place with great antiquity and one of the 12 Jyotirlingas (auspicious places of Shaivite worship). Bhima criss-crosses the districts of Pune and Solapur before flowing in Karnataka state, it has 12 tributaries in Maharashtra, Sina being the last. Sina is one of the larger tributary flowing about 55 km from its source near Ahmadnagar. The temple complex is situated with the confluence on its south east. The twin settlements of Hattarsang and Kudal are at a distance of 1 and 2 km from the confluence.

The Harihareshwar temple is the oldest, probably from 11th CE, Kalyani Chalukyan period. It has a twin sanctum plan with a common rectangular swargmandapa, the temple adorned with intricate and major sculptures. Found in 1980s, buried under the flood debris, the temple is recently restored and protected by State ASI in 2018. Adjoining Sangameshwar temple, a four sanctum plan, is on a slightly higher ground probably from 12th century but having a controversial inscription stating the date as Shake 940 (1018AD). The inscription clearly is first Marathi inscription and has an interesting proclamation translated as ‘victory to those who read’. The precinct has many inscriptions proving that it once was a major religious center in the region (Ritti and Kumbhar, 1986). Both temples face each other, aligned with a slight tilt to east- west axis. The Sangameshwar temple was perhaps restored in 18th CE and the latest restoration was in 1980s.

The temple complex has a very intimate relationship with all villages in 5 km radius, though Hattarsang – Kudal Grampanchayat plays a more active role in organizing the festivals and managing the temple complex. The villages also have a very intimate relationship with both the rivers which are encircling the farmland of these villages, they routinely swim, fish and draw water for farming and daily needs.



Figure 9: Confluence point of Sina and Bhima **Figure 10: Modern Ghat descends to riverbank**



Figure 11: Sangameshwar Temple faces north and east. **Figure 12: Harihareshwar Temple faces west**



Figure 13: Hattarsang Kudal Temple Precinct in its setting

Approach to the temple precinct is from north gradually rising to the higher ground, a path goes down encircling the temple on west to the confluence in south east. No historic ghat is existing, perhaps washed off in some great flood when the Harihareshwar temple was buried. Remnants of some steps and terraces are seen on the south of the enclosure wall of Sangameshwar temple which perhaps was a ghat in some distant past. There is a need of excavations on the eastern bank, some remnants of high steps can be seen there which could have been retaining walls of terraces. There is less erosion at the inner tip of the confluence, as here Sina meets Bhima in exact right angle. However a new concrete path gently sloping down towards the confluence is constructed, probably in 1980s with the restoration, it has wide steps in some portions and a large terrace at the edge of the confluence.

Both the temples are situated at considerable height from the level of the flow, still for some reason the Harihareshwar temple was buried under soft alluvial mud. Probably the river was flowing at this height 8 centuries ago and now it has carved itself deeper by several feet. Sangameshwar temple enclosure does not allow any glimpse of the confluence, perhaps Harihareshwar temple also had a high enclosure wall once, lost under the debris and recently reconstructed only up to 1.2 m. The view of the temple precinct from the confluence point or across the Sina is shrouded in a lot of greenery, temple grounds have levelled base and undulating slopes on south and east. The precinct is visited by more pilgrims than casual visitors, however since a decade rising awareness about the temple has brought many tourists and heritage enthusiasts to the place. The villages have benefitted from this trend.

5. Conclusions

All the three temples are situated at considerable height above the average level of the river. Except comparatively modern temple at Saswad, other temples have high enclosures severing the visual connection with the confluence point. However they all have physical connection with the riverbank in the form of Ghat. Ghats are used for the dual purpose of protecting the riverbank from erosion and for letting the pilgrim access the water easily and safely. The ghats have many terraces for religious rituals and recreational seating. Ghats at Nira Narsingpur and Saswad are very well designed and executed and performed their functions for many centuries showing how well the Maratha temple and Ghat builders had perfected their design and construction technique.

All temples have enhanced the confluence points through their siting, planning, architecture and associated cultural practices. These temples have forged cultural bonding not only with the settlement but a larger region of religious and cultural influence. The shrines are well known not only for their scenic surroundings, their exceptional architectural beauty but also for the layers of cultural and religious history that have been added through anchoring the community for centuries.

In contemporary times the scenic natural sites are in great demand for commercial ventures for their capacity to attract tourists. However in Indian architectural and cultural history palaces or houses were

not sited at the confluence points but the abodes of god. This is a difference in ideology and perspective. The enjoyment of beauty, the visual pleasure was subservient to religious devotion and spiritual attainment. The confluence offers the pilgrims a chance to bathe in two rivers, if it is considered auspicious for human beings the same is applicable for the gods. Rather humans would offer everything that is beautiful, precious and wonderful to the god. That is the reason why the confluence sites were chosen to place the shrines. Peace, stability, quietness were values, they were also necessities for religious advancement and spiritual attainment. Offering to god the best in life was a common practice. It was putting god before self, at the same time seeing god in all living things, in nature and in public welfare. The confluence sites became places at the conjunction of self, community and divine. The design aspects served to enhance this union.

6. Future directions

This paper presents an overview of the possibilities such a comparative study could open. A more detailed and deeper study is warranted for understanding the intricacies of planning. The historic temples and ghats on riverside surely have a great merit in terms of siting, planning, detailing and execution which must be recorded and used for contemporary education and design practice.

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“ASSESSMENT OF TOURIST POTENTIAL OF KHARDA”

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Abstract:

India has multiple layers of history even in its small villages and towns. These historical places are now valuable as heritage and must be conserved. Good tourist infrastructure at these places will generate local-regional tourism which will develop local employment. Kharda in Ahmednagar district of Maharashtra state in India has been a witness to important historical events. The battle of Kharda fought in March 1795 between the Maratha confederacy under the Peshwa of Pune and the Nizam of Hyderabad supported by British army. The Nizam was defeated and was Maratha's last victory. The fort and many other related places are important tourist destinations in the region. The construction and development of tourist infrastructure is necessary. Aim of the research is to Assess Tourist Facilities and Infrastructure of Kharda Village. The objective of this paper is to record existing status of tourist infrastructure and recommend policies for improvement. This research paper explains about various tourism assets in Kharda village. Assessment of existing tourism infrastructure and services are done with the help of different parameters through simple random sampling. Secondary data helped to identify the parameters to study and they are Condition of city roads', 'traffic management', 'public utilities at tourist attraction', 'parking facility at the tourist attraction', 'general cleanliness at tourist attraction and area around', 'quality of roads', 'condition of traffic and transport signage' and 'condition of signage. Mixed type research methodology is applied and Researcher's observation, questionnaire survey involving local citizens and tourists are the respondents considered to conduct this research. The study is leading to recommendations for ULB and tourism department.

Key Words: - Tourist, Infrastructure, Services, Tourist Amenities, Kharda

Introduction:

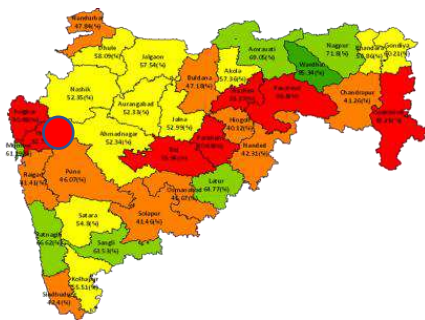
India has always been famous for its rich heritage and ancient culture. So, the onset of *heritage tourism in India* was long anticipated. Tourism is the activities of people traveling to and staying in places outside their usual environment for leisure, business or other purposes for not more than one consecutive year. Tourism boosts up economic activities through its multiplier effects and exploits local cultural and natural specialties in a positive way. Tourism potential refers to the ability of a site to attract and receive tourists with concerns about accessibility, resource quality, interpretation of resources, and so on. Where tourism infrastructure is the basis of tourism development and utilization of existing destination resources. Tourism infrastructure includes a large number of services, necessary to meet the needs of tourists and increase satisfaction during their stay at the destination.

2.1 Background and Context:

Kharda is the village from historical time .the fort of Kharda is built in 1745 by Sardar Nimbalkar. There is a barawa and mosque inside the fort. There are 12 Jyotirlinga in the village and there is a huge crowd of devotees in month shravan.

A historical fort at Kharda is tourist attraction. It commemorates the battle of Kharda fought in March 1795 between the Maratha confederacy under the Peshwa of pune and the Nizam of Hyderabad. The Nizam was defeated in the battle and was Maratha's last victory battle. The fort is at ground level and still in good condition.

Kharda is now a village but during Peshwa rule times it used to be one of the major towns of Ahmednagar. It was also the trading hub of goods between the districts Ahmednagar, Beed, Osmanabad and Solapur, Dewas.



Maharashtra



Ahmednagar



Jamkhed

Location Map of Kharda

Map No – 1

Source: Google Map

Developed by Author

1. Literature review:

The need for the topic is understood by the news in **Prabhat (Dainik Prabhat, 2016)** and **Lokmat (Lokmat, 2016)** newspaper published on **20 Dec 2016**. By reducing infrastructural disparities across the board, a place may maximize its tourist potential. Tourist facilities including hotels, roads, and transportation services are insufficient in Kharda. The preservation of the historical landmark requires tourism infrastructure.

”Assessing Tourist Infrastructure of the Satara District: The Views of Visitors” (Bhola, 2013). Tourists will continue to be put off by insufficient aircraft capacity, outdated airports, subpar lodging, bad roads, a stretched-thin train system, exorbitant taxes, and a cumbersome visa application procedure. Numerous geopolitical, security, infrastructure, and sectarian violence issues pose a danger to India's capacity to grow as a popular tourism destination. The purpose of the paper *“The Development of Tourism Industry in Indonesia: Current Problems and Challenges”* (Dr. M. Agus Cholik, 2017) is to analyze the issues and difficulties the Indonesian tourist industry has encountered. In the tourist sector, infrastructure is of utmost importance. The three elements of data reduction, data presentation, and conclusion or verification activities carried out in an interactive format are taken into account in this analytical approach.

“Infrastructure as Important Determinant of Tourism Development in the Countries of Southeast Europe” (Sonja JOVANOVIĆ & Ivana ILIĆ, 2016). A study looked at the connection between infrastructure and the competitiveness of Southeast European states as tourism destinations. The four major types of tourist infrastructure include physical, cultural, economic, and governance-related elements.

Tourism Infrastructure, Recreational Facilities, and Tourism Development (Mandic, 2018). Recreational facilities are a crucial component of the physical infrastructure, which is a crucial pillar of the entire growth of the economy and tourism. Infrastructure is a crucial component of every modern tourist resort. It is an obvious aspect of the tourist product that affects the vacation experience, along with technology and other tangible components.

A Methodology for Assessing Tourism Potential: Case Study Murshidabad District, West Bengal, India (Mamun, 2012). If organized well, tourism may significantly contribute to economic growth, social benefits, and sustainable development. The above challenges have grown in importance in India during the past ten years. Although the process is straightforward, the researchers should use caution when choosing qualities.

4.1 Tourism in Kharda



Fort of paranda



Ahilyadevi's wada at

Image no.1



Rameshwar Temple

Sources- Author



Sautada Waterfall

4.2 Tourism Near By Kharda in 20 Km:-



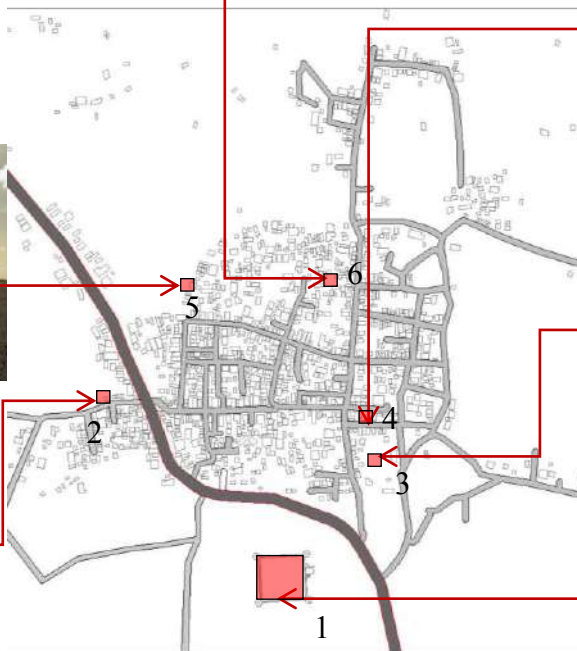
6. Mallikarjun Temple



5. Gite Baba Samadhi



2. Sitaram Baba Samadhi



KHARDA VILLAGE MAP



4. Jyotirlinga Temple



3. Nimbalkar Samadhi



1. Kharda Fort

Map No – 02

Image No – 02

Sources: - Google Map

Image Credit: - Author

Developed by Author

4.3 Tourist Spot and Their Predominant Character:

Tourist spot	Attraction	Predominant Character
1. Kharda Fort	Fort, Mosque In Fort, Ran tekadi, Temple In Fort	Heritage (Maratha empire)
2.Nimbalkar Wada	Wada, step well	Heritage (Maratha empire)
3.Nimbalkar Samadhi	Riverside Samadhi	Heritage (Maratha empire)
4. 12 Jyotirlinga Temple	Temple Of Mahadev	Religious - Hindu (Dravidian style)
5. Gite Baba Samadhi	Samadhi of saint ,on occasion of wari all Followers gather here	Religious - Hindu
6.Sitaram Baba Samadhi	Well known saint Samadhi	Religious - Hindu
7.sautada waterfall	Here people gathers in rainy season to enjoy the waterfall	Natural
8.Rameshwar temple	Temple of mahadev in valley of sautada	Religious - Hindu
9. Wada at chondi	Ahilyadevi holakar's birth village and their house	Heritage (Maratha empire)
10. Fort of paranda	Historical fort from nijam's period	Heritage (Nawabi period)

Table no. 01 Sources- Author

5. Research Question

What are the Tourist Facilities and Infrastructure of Kharda Village available for visitors?

5.1 Objectives:

- 1) To observe and record the condition of places of tourist interest in and around Kharda.
- 2) To identify the problems regard to tourist infrastructure.
- 3) To analyse existing conditions of tourist facilities and suggest ways of improvement.

5.2 Scope of Research:

This research assesses current state of tourist infrastructure with respect to certain parameters. The research uses data from common tourists, local service providers and researcher's own observations to comment upon current scenario. It further tries to develop some guidelines for ideal infrastructure conditions.

5.3 Limitation of Research:

The data from any government agencies is not sought. The research only uses primary data. Within available time frame the sample size of respondents was very limited. Still the observations remain valid and the research may be replicated for larger sample size.

5.4 Relevance of study

Not every Research topic in architecture will actually comment or work in architectural domain but it may also work in planning domain. It is regional level planning vision of people that come should in focus. And I am also going to comment on various architectural aspects related to infrastructure provided in Kharda.

Kharda has an historical background and due to lack of knowledge about its history new generation didn't knows about the fort And the people who visits the Kharda faces issues related to tourism infrastructure with the study of this paper we can give information about the tourism places in Kharda and solves problem related to the tourism of Kharda.

6. Methodology of Research:-

This study included both qualitative and quantitative research methods. For the purpose of gathering primary data, focus groups, interviews, and site inspections were all used as sources. Online polls were taken in Jamkhed and other well-known tourist locations as well as in adjacent cities. The findings of the online and offline surveys help us to identify the problems so that we may offer recommendations for improving the tourism infrastructure.

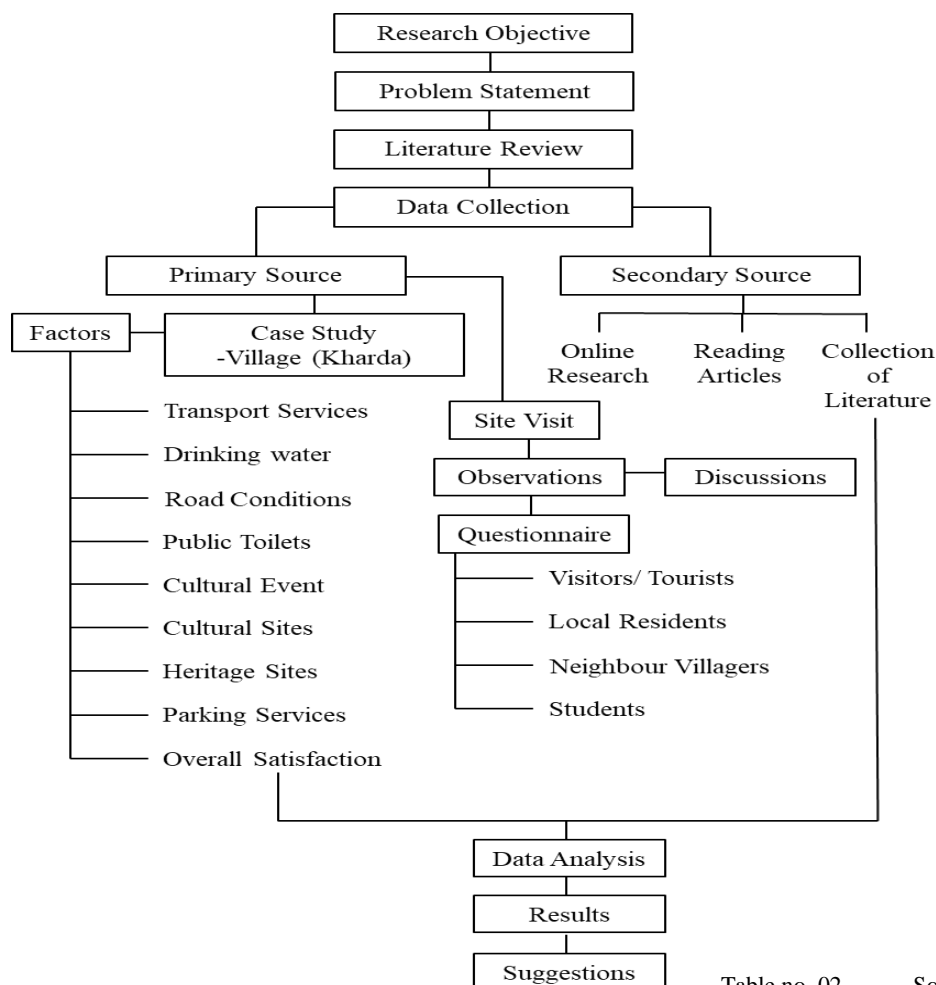


Table no. 02

Sources- Author

7. What Are the Standards for Best Ratings:-

No.	Tourist Spot	Tourist Spot
	Parameters	Best (10)
1	Transportation	Public Vehicles and Private Vehicles
2	Parking Facilities	Shelter, paved block, lights, markings and concrete driveway
3	Public Toilets	Separate toilets for male and female, W.C, wash basin, roof, flush, one unit for physically challenged person,
4	Street Light And Signage's	Well focused pole light
5	Road Connectivity	Tourist spot should be connected with good road condition and having good transportation services.
6	Drinking Water Facility	Clean filtered RO water, cleanliness near filter unit
7	Condition Of Monuments/ Tourist Spot	Current Condition of the Historical Monument
8	Small Vendors	Polite and well planned shops accessible from tourist spot
9	Seat Outs	Well planned seat outs having good shelter and good furnished settings.
10	Availability Of Guide	Local guide should be there and there should be informative books

Table no. 03 Sources- Author

Data Collection

7.1 Transport

7.1.1 Public transport

Visitors can travel to Kharda by the State Transport Buses bound for Bhoom, Tuljapur and onwards from Jamkhed, which takes approximately 30 min or, can travel in their own vehicle. The visiting spots are as far away as 1 to 5 km from Kharda main town. The fastest way to reach Jamkhed from Kharda is to take a taxi which takes approximately 30 min. Kharda is just 22.9 km Away from Jamkhed. You will get many Auto Rickshaw and other ways from Kharda to tourist spots.



Table no. 02

Sources- Author

Map No – 03

Sources: - Google Map

Developed by Author

Nearby cities of Kharda:-

There are 4 main cities near the Kharda village i.e. Ahmednagar, Pune, Solapur and Osmanabad all four cities are connected by state highways. So, the information about the public transportation from Kharda to these cities, their distance and cost are provided in this table by collecting data from Google and some official websites. Some information about this city is as follows:

7.2.2 Private Vehicle:

Private vehicle is also a good option for family plan for visiting the Kharda. There are many advantages of private visiting to the destination. Such as direct visit to the spot without any stoppage like a public buses' stoppage. There was no limitation of the time and that why tourist can give visit any time to the spot. Also, there was no limitation of the people's seating capacity with respect to money. And private vehicles are good for stay at accommodation facilities. Private Parking facilities are provided at tourist spots and other accommodation facilities. Other advantages of private vehicle are tourist people can visit other places near Kharda village like waterfall, other forts etc.

7.2 Parking For Private Vehicle :

Parking is one of the basic parts of the tourist place and generally provided near the destination. Tourist people have easy access if parking is near the spot and also older people face less trouble. The parking area for private and public vehicles is not in good condition at all tourist spots of Kharda. The data of parking area is collected by researcher by actually visiting the spot, making enquiries about the parking area and measuring the distance from the parking to the spot.



Image no.03



Sources- Author

7.3 Transport facility from Kharda to tourist spot:

As we see in map that Kharda and their spots are comes under the radius of 5 km from the Kharda taxi stand. In Kharda there are 10 taxis are available for reaching the spots. 2-3 Taxis are also available at Kharda main bus stand for people who are visiting through buses. Taxis are available from morning 7 am to evening 7 pm. The distance of the spots is calculated from the Google earth and one way cost data is collected by making enquiries with the taxi drivers and peoples of the Kharda.



Map showing distance from taxi stand to spot

Map No – 04

Sources: - Google Map Developed by Author

7.4 Public Toilets:

Public toilet is an important part of tourism infrastructure. Every tourist needs toilets for basic activities. These toilets should be useful for every person. These toilets need to design barrier free. In Kharda there are no public toilets present near the tourist spots. Hygiene of toilets is not up to mark. At some tourist spots mobile public toilets are installed during events only, they need to be installed permanently as per need.



Image no. 04

Sources- Author

7.5 Informative Boards For Tourist Attraction:

Informative boards are an important part which help us to reach the destination correct way and safely. These helps the people who visiting the Kharda for first time. Generally, the signage's are provided near the roadside and on turnings of the roads. In Kharda the wall painted posters are provided at the highways and secondary roads. The size of poster and height matters the more in tourist part. The bellow data is collected by personal visiting to the site and location of this signage. The researcher remark is filled by taking the data from international standards about signage.



Informative boards are not in good conditions. They need to improve.

Image no. 05

Sources- Author

7.6 Road Condition

Road condition matters more while visiting the long route tour and specially visiting to the village tour. Everyone wants a safe journey, so for that roads should be well maintained and cleaned. Below images shows the present road condition of Kharda. By observation and personal visit to the site it shows that condition of present roads of Kharda is poor. Roads are made up of medium sizes stone asphalt and Bitumen. These roads are not maintained properly and cleaned. The internal roads of Kharda are not in good condition to improve tourism they must need to repair.



Image no. 06



Sources- Author

7.7 Drinking Water Facility

Drinking water facility is one of the most important activities in tourism. Drinking water should be clean and clear. The most important part is cleanliness. In Kharda there are no drinking water facility available near tourist spots. at some tourist spot drinking water facility is available but only during events that are not permanent. Drinking water is not RO purified. Information about the facilities was collected by the researcher by actually visiting the places and making enquiries about drinking water.



Image no. 07



Sources- Author

There are public drinking water sources are available but they are planned for villagers And at the time of event drinking water facility is temporarily as above .So there is need to provision of filtered drinking water for tourist near each tourist spot.

7.8 Condition of historic monuments:

In Kharda there are **Historical Monuments** but due to wars and natural disasters these monuments are damaged. At Kharda fort entrance vegetation produced on the walls of fort, also the steps in fort are broken. There is a mosque inside the fort but that is also affected due to algae. In 1991 there is an earthquake due that nimbalkar wada collapsed. The nimbalkar Samadhi is also not in good condition due to wars and natural disasters. These historical monuments have a tourism potential but that are not well maintained they need to be conserved. These are representative spots there is Deterioration on another spots also they need to be repaired.

7.9.1



Image no. 08

Sources- Author

The vegetation is appeared at entrance gate of fort

7.9.2

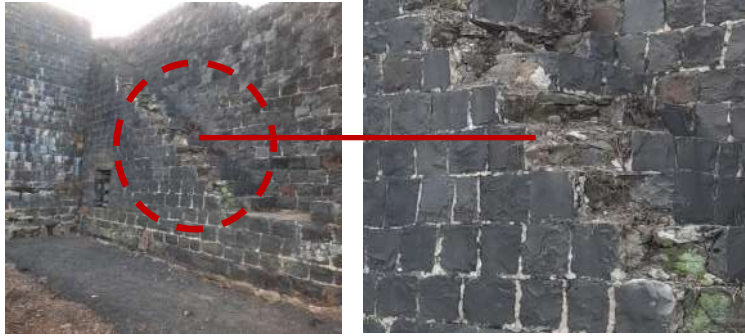


Image no. 09

Sources- Author

The Deterioration of steps in fort

7.9.3



Image no. 10

Sources- Author

The weakening of mosque in kharda's fort where algae is produced on walls of the mosque

7.9.4

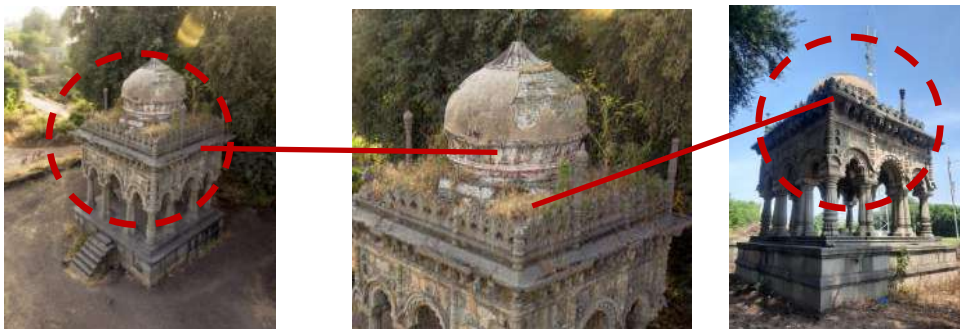


Image no. 11

Sources- Author

The deterioration of nimbalkar Samadhi's tomb where the vegetation and algae is produced

7.9.5



Image no. 12

Sources- Author

The deterioration of nimbalkar wada after the 1991 earthquake and the vegetation Produced on it

7.10 Hospitals available in Kharda:

Hospital is the basic need of human being. In emergency condition tourist need medical facility. There are 4 clinics in Kharda and one government rural hospital. For emergency patient multispecialty hospitals are available in Jamkhed.



Map No – 05

Sources: - Google Map Developed by Author

7.11 Seat Outs:

At some tourist destinations in Kharda, there is little provision for seat outs, and those that do exist are sometimes in poor condition. At Tree Seating, the elderly congregate. People had difficulty after a long walk around tourist attractions due to the unsuitable seating arrangements.

7.12 Local Vendors:

Local vendors are polite but the condition of shops are not maintained/ kept in good condition. They have capabilities of good business but they have no platform so they are lacking. There is need of well-planned shops near tourist spot to encourage their business and supplying unique identity of Kharda through their business.

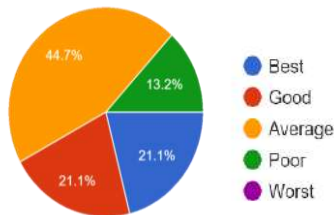
7.13 Local guides and information brochures:

Local guides and informative brochures\ booklets are the main source of knowledge. Through booklets one can show to others and suggest travelling. In Kharda there are no local guides and no other booklets at present condition. That facility need to provide in Kharda which can boost the tourism in Kharda.

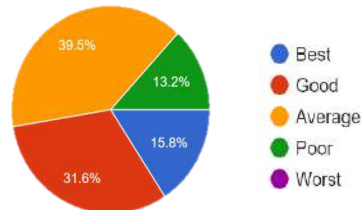
8. Data Analysis

8.1 Result through online survey :

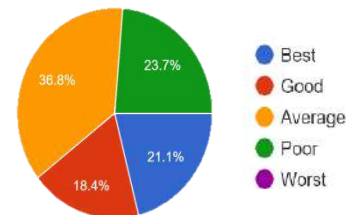
Online survey is done with the help local tourist from Jamkhed and nearby area. The survey form is circulated to 103 people out of which 38 recipients have submitted the form. The conclusion of survey is as follows,

1. Transport service in Kharda

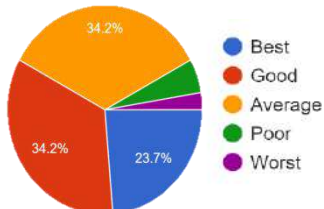
Overall transport service in Kharda is average according to survey there is need of development in transportation service

2. Drinking Water service in Kharda

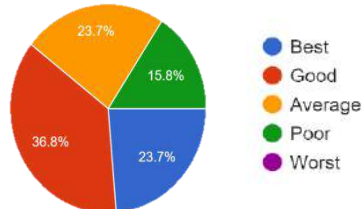
According to survey drinking water service is up to mark but hygiene should be maintained at every spot and drinking water should be RO filtered.

3. Road condition in Kharda

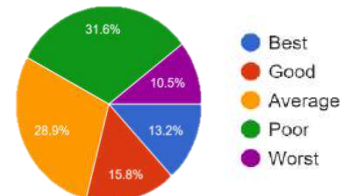
Roads in Kharda are not in well condition they are with cracks and potholes. They need to maintain time to time.

4. Public Toilet service in Kharda

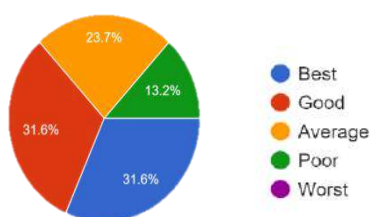
Public toilets in Kharda are in worst condition and temporary installed at the time events only so there is need of permanent toilets

5. Cultural events in Kharda

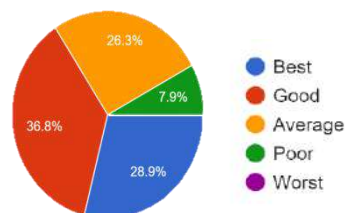
Cultural events in Kharda are very interesting and joyful according to respondents so there is no need of development.

6. Cultural Sites in Kharda

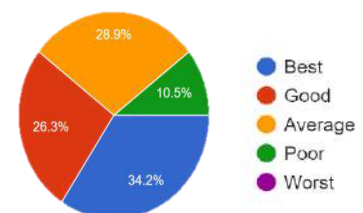
Cultural sites have no provision of sitting and tourism infrastructure at spots so there is need of development

7. Heritage sites in Kharda

Historical monuments in Kharda are decaying nowadays. Algae, vegetation are produced on monuments so there is need of restoration of monuments.

8. Parking service in Kharda

Parking in Kharda is average condition. There are no shades and hard paved surface for parking.

9. Overall Satisfaction of visiting Kharda

Many peoples in Kharda likes the tourism spot but they are facing problem of lacking tourism infrastructure. So there is need of development in tourism infrastructure.

8.2 Result Through Questionnaire Survey In Physical Mode:

Kharda is a village in Jamkhed Taluka from historical time. There are historical monuments and have tourism potential. In Kharda tourism is based on history, religion and natural. There are total 5 points to visit in historical tourism that are Kharda fort, Sardar Nimbalkar Wada, Sardar Nimbalkar Samadhi. Also in Religious tourism there are Sant Sitaram Baba Temple and Sant Gite baba Samadhi and in natural tourism there is Sautada waterfall near to Kharda. But now a day in Kharda the tourism is lacking due to infrastructure. All observations are done with actual site visit and data collection with primary survey. The following table shows the actual observations-

No	Parameters	Tourist Spot					Average
		Fort	Nimbal. Samadhi	Nimbal. Wada	Gite Baba Temple	Sitaram Baba Temple.	
1	Parking Facilities	Average	Absent	Absent	Poor	Average	Poor
2	Public Toilets	Absent (At events only)	Absent	Absent	Absent	Poor	Absent
3	Drinking Water Facility	Absent (At events only)	Absent	Absent	Absent	Poor	Absent
4	Street Light And Signage's	Poor	Absent	Absent	Absent	Good	Absent
5	Small Vendors	Poor	Poor	Poor	Absent	Good	Poor
6	Seat Outs	Good	Absent	Absent	Absent	Good	Poor
7	Road Connectivity	Poor	Poor	Poor	Absent	Good	Average
8	Telephone /Mobile Services	Good	Good	Good	Poor	Good	Good
9	Availability Of Guide	Poor	Absent	Absent	Absent	Poor	Poor
10	Condition Of Monuments/ Tourist Spot	Average	Average	Poor	Average	Good	Poor
Average		Average	Poor	Poor	Poor	Average	

Table no. 04 Sources- Author

Parking at every tourist spot is lacking with basic services. Some tourist spot doesn't have parking and some tourist's spots have parking's but in open land having tree shading. There is not paved parking. Parking marks are not available on site. The parking at every tourist spot need to maintain and to be clean. Overall parking facility is poor in Kharda for tourism.

Street light in Kharda are not provided and not in good condition. There is light at tourist spot but not provides any sufficient light for users and some are broken. The new electric

poles are installed and on that light bulbs are installed. These lights are working with electricity and not on solar due to this bulbs consume more electricity.

Small Vendors do their job with respect to tourist spots. These vendors don't have any shelter / proper shops. The vendors are polite to service. But need their shops well planned.

Seat Outs are located at every tourist spot but that are insufficient according to users. These seat outs don't have any shed for protection from sun and rain. In Kharda fort seat outs are not well planned. Tourist need seat outs after sufficient walk but are not well maintained. The cleanliness about seat outs matters important, but at all tourist spots that are lacking.

Road Connectivity is not in good condition. The primary and secondary of Kharda have holes in it. That impacts on tourism. Some tourist spot has kaccha road connectivity. In rainy season that get blocked. Overall road condition in Kharda is not good and need to plan.

At all tourist spots network is good to all **Telephone Services**. But there is need of public telephone booth at every tourist spot. Public telephone booth with proper shelter should be needed to provide there.

8.3 Researchers' Observations

The Kharda is a historical village from ancient time. In past time it is the trade hub of Nizam which includes Ahmednagar, Beed, Solapur, Osmanabad and near about area. Sardar Nimbalkar ruled the Kharda and built historical monuments like fort, temples and his own wada. The Kharda is the village that witnessed the last winning battle of Maratha Empire. But nowadays Kharda is a simple village with zero development and it due to many people forgotten the history of Kharda. Government not focused the development of Kharda village and tourism in it.

In Kharda local body government should be focused on basic tourism services like parking, road conditions, drinking water, public toilets. Seat outs, local guides, informative brochures and street lights in Kharda according to all surveys and observations. The historical monuments condition are weakening nowadays, that monuments have a heritage importance so they need to maintain and restore time to time. Kharda is a village that have a huge tourism potential but due to infrastructure it lacking in development.

9. Conclusion

Kharda has a huge historical background, heritage and a number of tourist attraction points; hence it has a lot of tourist potential. Nowadays people in Kharda and near about area forgotten the history of Kharda. The disadvantage is that these tourist points are not maintained and lack of tourist infrastructure has led to zero development in tourist industry of Kharda.

10. Recommendations towards Improvement:

There is need of development in basic tourism services like parking, road conditions, drinking water and public toilets. Seat outs, local guides & informative brochures and street lights in Kharda according to all surveys and observations. So they are discussed as follows according to standards mentioned in table (2) and by referring other tourist spots like Mahabaleshwar, Raigad and Chondi.

I. Parking :-

Parking should be hard paved and having shed, this parking should be working in all-weather condition. In parking we can give different proposals but the basic tree shading parking is easy to install, that needs permeable paver surface sloping towards the tree pit. The selection of trees is heighted and shading shrubs *Shadbush*, *Mountain Laurel* and other trees. There is another type of parking shading with PVC/ Tensile roofing shade that is costly but works in all weather. The parking layouts should be marked and the lights should be provided.

II. Road Condition:-

Road network is the basic need for tourism. The roads should clean and clear without any potholes and cracks. The roads should have divider and driving mark outs. The divider should have trees and lighting in it. The roads should have radium spots that will glow in night. The roads should have signage's that will help tourist to reach the spot easily.

III. Drinking Water and Public Toilets:-

A. Drinking water: - Drinking water is the basic need of human being, that should RO filter and cool according to user. The tap should be clean, waste water should be reused in vegetation. The space near the drinking water should be clean and well maintained.

B. Public Toilet: - Public Toilet is the space where multiple users use it, public toilets should be clean and well maintained, gents and ladies toilets should be planned separately. The public toilets should have consideration for especially abled persons. The public toilet should be well maintained. Taps should be clean, basins should be well maintained. Ventilation for toilets should be good. The basic layout for public toilet may be as follows,

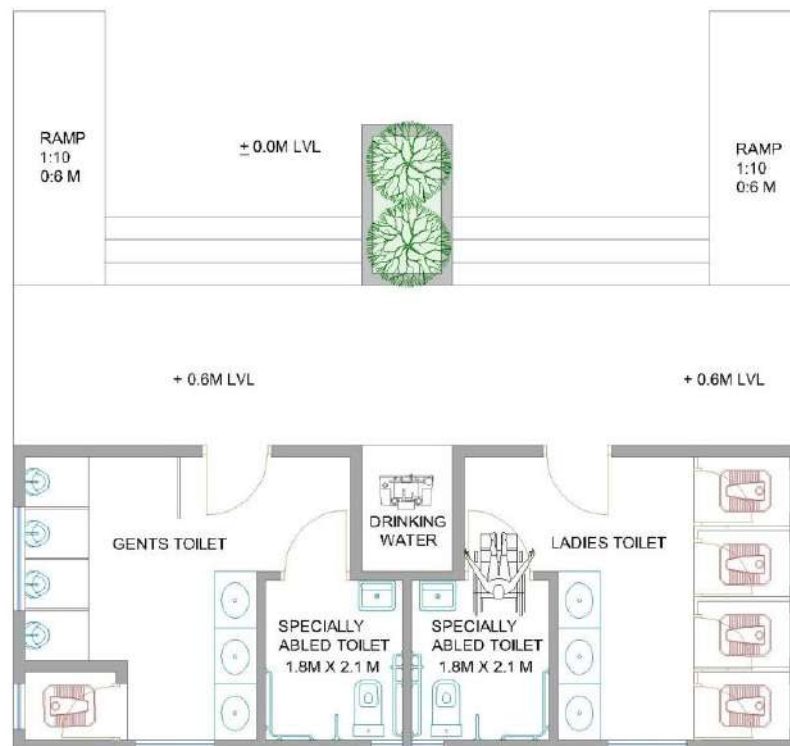


Image no. 13

Sources- Author

IV. Seat-outs:-

Sit-outs should be provided at every tourist spot where user can take some rest and will enjoy the tourist spot. These seat outs should also have provision of all age people and workable in all-weather condition. These seat outs should be designed in different ways but the economically best option is seat outs below the trees.

V. Local Guides, books & Information Brochures:-

Local guides should have knowledge about the history of Kharda. These guides should be polite and knowledge sharing person. Informative brochures should be well designed and consist of information about every tourist spot and near about area. These guides and brochures will help tourist for their weekends and tourism.

VI. Street Lights:-

Street light should be provided in divider where it should be designed on solar panels. This street light should be useful from 6.30 pm to 6.30 am. These street lights should be provided at every tourist spot which helps to user to access the tourist spot up to night.

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Impact of urbanization on energy demand in residential Neighbourhoods in Peri-urban fringes: A case study of Kolkata

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Abstract: Urbanization has a significant impact on energy demand in residential neighbourhoods. As cities become more densely populated, there is an increase in demand for energy which leads to higher consumption of energy resources. Kolkata has a 300-year history of growth as an Indian megacity and is experiencing fast urbanization in peri-urban fringes. National and international migration has resulted in population expansion, urban industrial development, and more economic opportunities, all of which have harmed the environment. Land usage and land cover are rapidly changing as a result of growing urbanization, with negative consequences for local land resources. The increased demand for energy has caused an increase in electricity consumption in residential neighbourhoods and increased emissions of carbon dioxide, which is a major contributor to global warming. In addition, urbanization in Kolkata has led to the construction of new housing projects, which require additional energy for heating, cooling, and lighting and an increase in the number of vehicles. Urbanization has also led to an increase in the number of industries in residential neighbourhoods. The research was carried out considering Kolkata in a period between 2005 and 2021. Spatio-Temporal analysis for Land Use and Land Cover, Normalized Difference Built Index, Growth Dynamics, and Non-Built Open Spaces was carried out after which the Ward wise level analysis was done based on population density, built-up density, Normalised Difference Vegetation Index, Land Surface Temperature, CO2 Emission Intensity and Electricity Consumption based on the data collected from census, research papers and GIS-based analysis. The study aspires to identify various policy instruments and linkages for possible interventions to endeavour an overall outline plan for mitigation through different recommendations on various levels of planning such as different energy efficiency strategies through greening measures, urban infrastructure-related measures including land use planning & bioclimatic architecture, and Anthropogenic heat reduction measures for reducing Energy Consumption.

Keywords: Urbanization, Consumption, Growth Dynamics, Policy

1. Introduction :

One of emerging countries' most significant demographic and economic trends is urbanization, which has significant implications for development, energy use, and well-being. It is a major demographic driver of energy demand. It is intertwined with various aspects of human behavior, including living and working arrangements and the organization of economic activity. However, it is just now beginning to be explicitly incorporated in long-term energy and carbon scenario calculations. Economic theory postulates that urbanization is caused by economic growth and social modernization (Avtar et al., 2019). This structural transformation of rural areas into urban hubs affects energy consumption significantly through various channels. For example, urbanization increases energy consumption by raising the demand for housing, food, public utilities, land use, transportation in urban areas, use of more electric

appliances, the rise in demand for road use, globalization, etc. In recent decades, urbanization has been growing rapidly. The world urban population was 1.52 billion in 1974-75 which steadily increased to 3.29 billion in 2006-07 that is projected to double in 2050. This rapid increase in urbanization will generate more pressure on existing urban infrastructure e.g., housing, health, education, power, transportation, and other public utilities (Shahbaz et al., 2016). Urban dwellers consume higher quantities of resources and add pressure to the sensitive ecosystem. International Energy Agency reports that big city dwellers accounted for 67.77 percent of world energy use. This implies that the continuous increase in urbanization will significantly impact energy consumption.

With the rates of urban expansion urban land use and land cover pattern hugely change with time. The environmental impacts of land use change are the results of the urbanization process. According to various researchers, urban area occupies only four percent of the total land surface but it impacts the physical environment and social environment (Seto et al., 2011). Urban expansion also causes habitat destruction, resource destruction, loss of biodiversity, and fragmentation of landscape. The extreme impact of urban expansion leads to the scarcity of water resources (Pannell, 2002b) and a bad impact on public health (Woodbridge et al., n.d.).

The study aspires to identify various policy instruments and linkages for possible interventions to endeavor an overall outline plan for mitigation through different recommendations on various levels of planning. Recommendation for different energy efficiency strategies through greening measures. Urban infrastructure-related measures including land use planning & bioclimatic architecture, and Anthropogenic heat reduction measures for reducing Energy Consumption.

2. Study Area :

Until 1912, Kolkata (formerly Calcutta) served as both the capital of the British Indian Empire and the Indian state of West Bengal. It is situated in a straight line running north to south along the Hooghly River's east bank (Fig. 1). With 24,306 people per square km, it is one of the biggest and densest cities in the world (Census, 2011). With a rate of 3.94% from 1991 to 2001, this city's population grew quickly (Census, 2011). According to the Census of 2011, the city, which has a total size of 185.52 square kilometers, is divided into 144 wards, or local administrative entities (KMC). The Kolkata Metropolitan Development Authority (KMDA) has designated KMC as the first-order metro hub of the city (KMDA). The Central Business District is located in the oldest and most central portions of KMC (CBD). Since its inception, Kolkata has been a significant hub for business, trade, and commerce and offers a wide range of services.



Figure 1: Location of the Kolkata (Kolkata Municipal Corporation) under the state of West Bengal of India) along with ward boundary and sample survey sites.

Source: j.scs.2021.102715

Only Kolkata, India, has overcome a troubled colonial past to become one of the world's largest cities. Mass migration has historically helped Kolkata grow, which has increased the need for more residential

spaces. The LULC modifications are rapidly changing their behavior at the same time that they are encroaching on the natural landscape. Despite estimates that the population increased by 1.88% between 2001 and 2011 (Census, 2011), the rate of built-up expansion is steadily moving in diverse directions as a result of the concentration of various economic activities. Therefore, the UGS is still vulnerable to potential loss due to future urban expansion. From this perspective, we try to find out the pattern of LULC change and its future prediction to investigate the trend of green space coverage using multiple land-use transition models to enrich the sustainable land-use plans for the city (Dinda et al., 2021).

According to the 2011 Census, there are 14.72 million people living in the KUA, with a population density of 7950 people per square kilometer. Almost 83% of the populace there resides in formally recognized urban areas (Statutory Towns- STs). However, between 2001 and 2011, the population growth rate in these areas was much lower (0.49% per year) than it was in the rural areas outside the KUA (2.22% annually). This high pace of population growth in the periphery, especially within the CTs within, has further fueled the growth of built-up areas and the increase in population density. Such nominally rural areas are hotspots for rapid and unplanned urban expansion due to a lack of institutional capacity, lax/rarely enforced contracting/building restrictions, and proximity to a major urban center, showing the unacknowledged/hidden urbanization occurring in India. The ecologically sensitive East Kolkata Wetlands, a designated Ramsar site, which is located along the eastern edge of the KUA, have been negatively impacted by this urbanization, and fertile arable lands, surface water bodies, and green belts continue to be transformed into built-up surfaces at unprecedented rates, impairing the crucial balance between natural and man-made landscapes and decreasing the health of ecosystems. (Zeug & Eckert, 2010).



Figure 2: Evolution of Kolkata

Comprehending the spatial-temporal patterns of KUA's expansion is therefore crucial to exploring its trajectories and the areas/landscape elements most likely to be impacted, which is paramount to fostering sustainable urban growth.

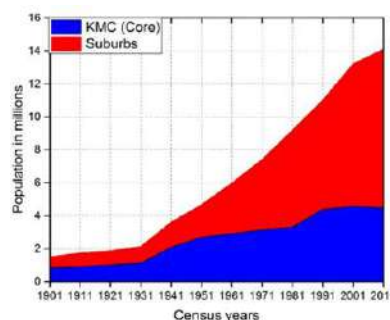


Figure 3: Decadal population accumulation in KMA and suburbs of KMA during 1901–2011

Source: <https://www.mdpi.com/2072-4292/13/21/4423/html>

3. Methodology :

3.1 Collection of Data (Images & Information):

This study is based on satellite images. Satellite images have been collected. For the analysis cloud, free images of the same time this study is based on satellite images. Multi-temporal city maps and two scenes of satellite multi-spectral images are collected for evaluating the temporal and spatial characteristics of urban expansion from 1990 to 2021 and the land use land cover change between 1990 and 2021.

3.2 Multi Linear Regression Model :

In this Research for analysis multiple linear regression (MLR) also known simply as multiple regression, is a statistical technique that uses several explanatory variables to predict the outcome of a response variable which have been used. The goal of multiple linear regression is to model the linear relationship between the explanatory (independent) variables and response (dependent) variables.

3.3 Spatial Regression Model :

Spatial Regression Models illustrate the use of spatial analysis in the social sciences within a regression framework and are accessible to readers with no prior background in spatial analysis it was used to derive the correlation map among the independent variable and dependent variable.

3.4 Ordinary Least Square Model:

In this analysis Ordinary least-squares (OLS) model was used. It assumes that the analysis is fitting a model of a relationship between one or more explanatory variables and a continuous or at least interval outcome variable that minimizes the sum of square errors, where an error is a difference between the actual and the predicted value of the outcome variable. The most common analytical method that utilizes OLS models is linear regression (with single or multiple predictor variables). Hence Based on the Moran Curve the method is chosen.

3.5 Shannon's Entropy:

In this research, Shannon's Entropy Model was used for the growth directional analysis and to see where the city's growth trajectory is. It was performed on Kolkata and its periphery.

3.6 Mapping techniques and Software:

For the analysis, both the remote sensing and GIS techniques have been used For mapping purposes, various cartographic techniques have been used. For mapping purposes, Arc GIS 10.4 and USGS, Landsat Imagery software have been used. To scrutinize the demographic growth and surface temperature prediction statistical analysis has been done. For the calculation of NDBI and NDVI indices, LANDSAT has been used. For the mapping of land surface temperature, Arc GIS 10.3 software has been used. For the future prediction of the surface temperature, Microsoft Excel 2019 has been used.

4. Analysis and Discussion :

4.1 Preliminary Analysis:

Kolkata was the capital of British India until 1911 when it was moved to Delhi, and it had another identity 300 years ago as a port city. It is now the capital of India's West Bengal state. It was the only city in India with the designation of a metro city at the turn of the century, with a population of more than one million. Kolkata's urban agglomeration (UA) population grew from 1.55 crore in 1901 to 14,035,959 in 2011.

For the preliminary analysis, the spatial-temporal analysis was done firstly for land use and land cover change from the time scale 1990 and 2021. Hence the Landsat image taken from those years with 30 m spatial resolution is used for the analysis. After this spatial temporal-built index was taken for analysis to study the transformation from non-built-up spaces to built spaces due to urbanization, after which the urban landscape, growth rate, and non-built-up spaces were studied over the years from the time scale of 2000 to 2010 to 2020 to see how the different region of Kolkata is transformed due to various factor and henceforth delineating the region based on the observation for further analysis for finding out the correlations.

The correlation ship that will be further performed based on the indicators that show the relationship will further delineate the regions for showing the high and low correlation ship in them to establish the relationship and then do comparative analysis for the reasoning of such ward based on their situational and condition of the neighborhood.

4.2 Spatio Temporal Land Use and Land Cover Change:

One of India's earliest cities was Kolkata. Its geopolitical significance was first established during the British reign in India. Since then, it has served as both a political and economic powerhouse in India, known as the central business district (CBD). People from the neighboring periphery area are fascinated by the city's strategic location. As a result, there is a shift in the megacity's land use and land cover. Four decadal land-use land-cover maps are shown clockwise, namely 1991, 2001, 2011, and 2021. The figure depicts the megacity's and its environs' significant changes in urban land use and growth models. Fallow land dominated the majority of the land, accounting for 51,176 ha (41%) in 1991; the built-up area was just 23,834 ha (19%) (Reis, 2008).

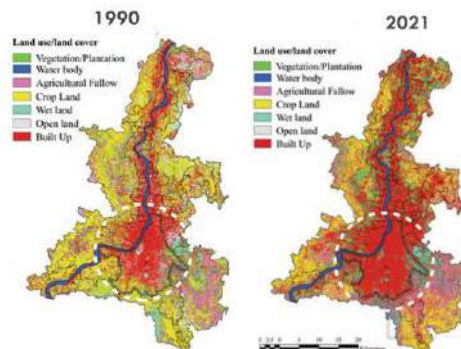


Figure 4: LULC of Kolkata Agglomeration for 1990

The built-up area developed rapidly by 49.16 percent between 1996 and 2006, at a pace of nearly 5% per year; however, the rate of expansion dropped to 31.32 percent during the next decade, from 2006 to 2016. Between 1996 and 2006, the decadal growth rate for mixed built-up above KMA went from 1.24 percent to 10.48 percent, and between 2006 and 2016, it increased from 1.24 percent to 10.48 percent. The yearly and decadal growth rate phenomena in the KMA-urban and KMA-rural indicate significant dynamics when compared to the entire KMA.

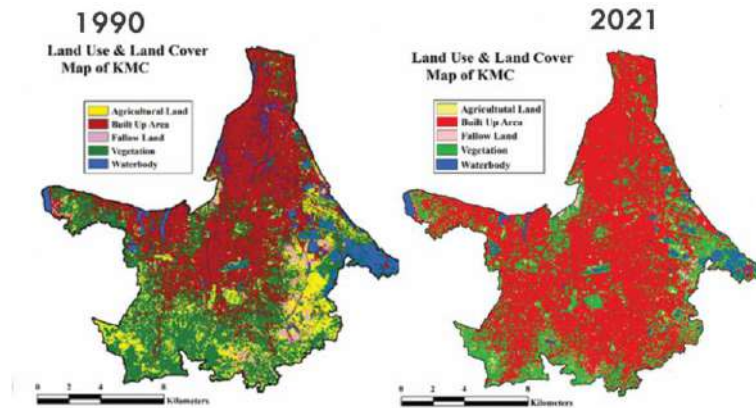


Figure 5: LULC of KMC boundary for 1990- 2021

4.3 Spatio Temporal Built-up Density:

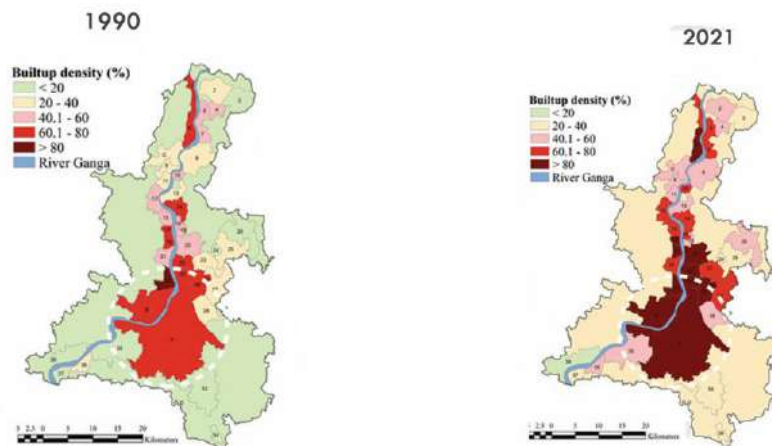


Figure 6: Built Index of Kolkata Agglomeration boundary for 1990- 2021

4.4 Growth Rate:

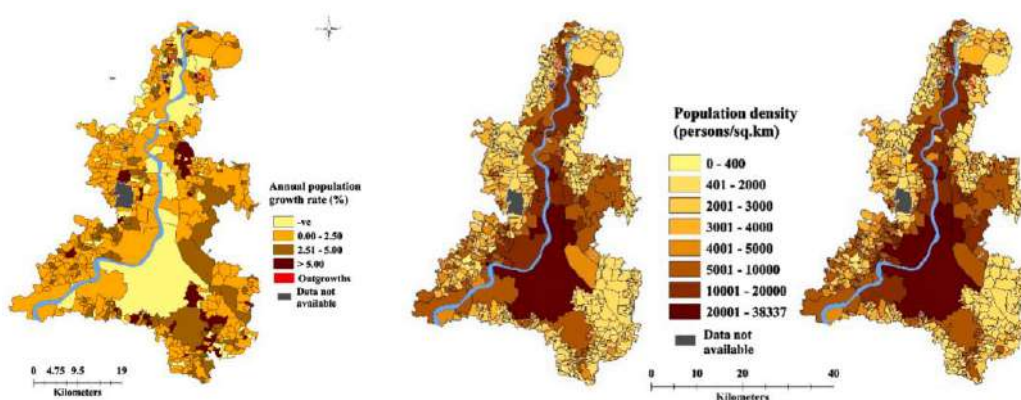


Figure 7: Growth Rate for 2000- 2010-2021

Results reveal a marked increase in the urban land share, from 20 % in 2000 to nearly 50 % in 2018, when about 75 % of the built-up spaces comprised the high-density urban core. Urban growth patterns in KUA show clear intra-urban variations between inner and outer spatial extents. The inner city zone underwent coalescence with nearly 90 % of the built-up growth within the inner city high-density urban core becoming the most significant spatial built-up typology in the study area in the examined time

period. Such growth of the city core, particularly its expansion towards the periphery, primarily happened at the expense of both urbanized and non-urbanized open spaces. The spatial territories present in the periphery were also the most dynamic.

4.5 Urban Settlements:

The direction of changes in land use and land cover is heterogeneous. The relationship among urbanization (UII), vegetation (VII), and water (WII) are very important an ecological perspective. The amount of water and vegetation determines the local climate as well as the urban heat island. The urbanized area/built-up area captures solar energy and heats up the environment. The relationship between urbanization/built-up area and vegetation cover and urbanization/built-up area and water body are inversely proportional.

In 1980, vegetation areas dominated by large trees virtually encompassed 29 percent (58.60 Km²) of the whole KMC area, and by 1990, they had expanded to 39 percent (81.12 Km²). Since then, the area covered by vegetative patches has steadily decreased, covering just 17% of the overall KMC area in 2000 and 21% in 2021. The biggest decadal population growth in Kolkata UA was 69.34 percent from 1941 to 1951, while the lowest was 6 percent in the last decade. After 1961, the rate of expansion began to slow. The increased demand for land to create communities is a result of this geometric expansion. As a result, the land transition from undeveloped to develop occurs, as well as urbanization.

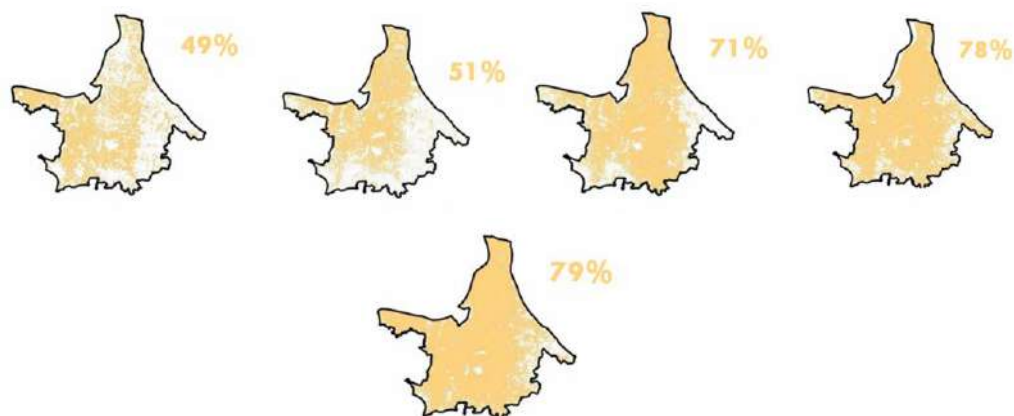


Figure 8: Urban Settlements in the year 1980-1991-2001-2011-2021 shown in serially.

4.6 Vegetation Patches:

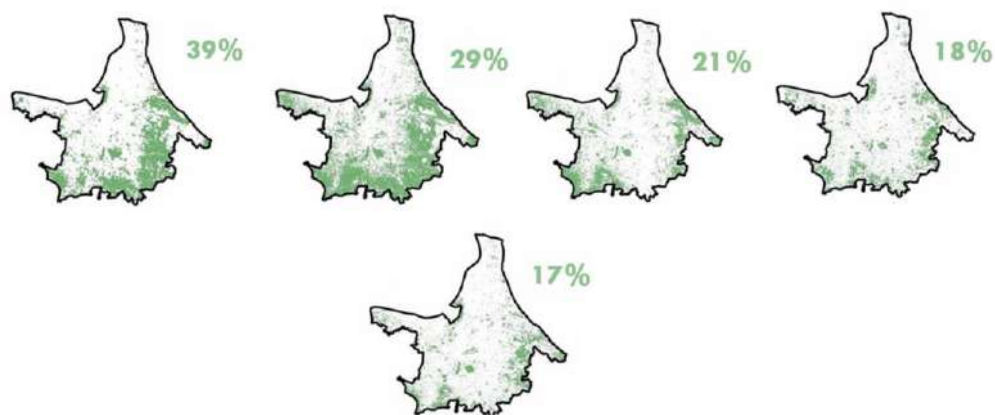


Figure 9: Vegetation Patches in the year 1980-1991-2001-2011-2021 are shown in serially

From the NDVI images of Kolkata city of 2005, it has been found that values for NDVI range from 0.71 to 0.89. In 2005, the amount of vegetation is very low in the Central Business part of the area which is slightly high in the northern parts of KMA i.e. towards Kalyani city, but it experiences very high in the western parts (rural blocks of Hooghly district) and northern parts (rural blocks of Nadia district). The percentage of vegetation cover in this area is comparatively higher than the other areas. In 2010, the percentage of vegetation cover is very less in the CBD areas. These areas are totally vegetation-less areas.

4.7 Relationship between NDVI, LST, NDBI:

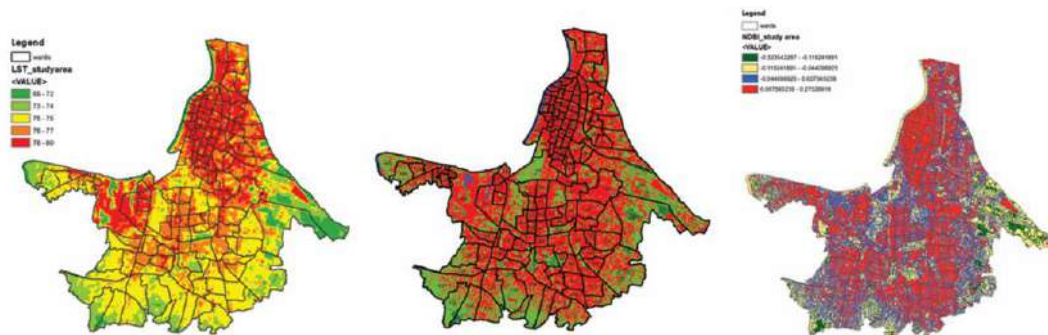


Figure 10: LST-NDVI-NDBI

The surface temperature of Kolkata city between 2005 and 2019. From the surface temperature image of 2005, it has been found that the maximum and minimum temperature during that time period is 26° C and 14° C. By analyzing this image, it has been found that the temperature is higher in the city core areas than in the peripheral areas. In 2019, the maximum and minimum temperatures experienced are 41° C and 23° C. By analyzing the surface temperature between these four-time periods, it has been found that the average temperature of this city has increased by nearly 20° C and 32 OC between 2005 and 2019.

For this reason, Kolkata city has been red from a heat island-like situation. It shows the distribution of surface temperature in Kolkata city between 2005 and 2019. From the temperature distribution in Kolkata city, it has been found that in 2005, nearly 1780 sq. Km. Of the area is under the 11 OC and 25 OC which experiences nearly 96 percent of the area. Only 3 percent of the area has experienced surface temperature i.e., 26 OC and 40 OC. From 2005, the area of low surface temperature has decreased very rapidly and high temperature increases very fast which converts Kolkata into a heat island-location. In 2019, the temperature in the core areas of Kolkata (CBD area, Central Kolkata area, etc.) Has reached 41° C which may be the cause of concern among environmental researchers and urban planners. Table 11 shows the distribution of surface temperature in Kolkata city. It changes in LST values in Kolkata. From the table, it has been found that the area with low temperature has decreased and the area between 26 OC and 40 OC has been increasing very rapidly which creates lots of problems for urban planners. According to an analysis of the NDVI, NDBI, and LST maps, Kolkata's high NDVI values are rapidly falling, while NDBI values are rapidly increasing, accelerating the rise in surface temperature. In 2019, the maximum temperature recorded in Kolkata city was 41 degrees Celsius. Figure 5 depicts the projected surface temperature in Kolkata till 2030. According to this prediction, the temperature in Kolkata city will rise to 53 degrees Celsius by 2030. The residents of Kolkata city will confront numerous challenges as a result of the high-temperature increase. To address this issue, policymakers and decision-makers will develop new policies to reduce the risk.

4.8 Energy Scenario in Kolkata:

West Bengal is the 10th largest consumer of electricity accounting for nearly 4.38% of total energy consumption in India. Owing to significant improvement in power supply, the State witnessed an only 0.5% energy shortfall in FY15, which is considerably lower than the national average energy shortfall of 3.6%. In terms of peak power requirement as well, the State has performed significantly better than the national average, as the peak deficit has been below 1% in the last 4 years as evident (Energy Agency, n.d.).

Generation West Bengal Power Development Corporation Ltd. is a state-generating company that owns and operates thermal power generating stations. In addition to WBPDC, private players own and operate the remaining thermal power generating capacity. CESC, HEL, IPCL, and central generating stations are owned by NTPC, NHPC, DVC, etc., and also some IPPs. Transmission West Bengal State Electricity Transmission Company Ltd. (WBSETCL) is the State Transmission Utility, responsible for developing and operating transmission systems in the State. Distribution utilities are operating in the State, with 2 being private licensees, 2 owned by State Government, and one owned by Central Govt. For the domestic sector, background trends suggest substantial growth in the number of households in the average energy consumption levels per household. These combined trends lead domestic sector energy consumption to rise by 40.7% from 16.5 TWh in 2014 to a forecast level of 23.3 TWh in 2025 (MOP_Annual_Report_Eng_2021-22, n.d.).

Comparison of Kolkata with West Bengal in 2018-19				
Sl. No.	Particulars	Kolkata	West Bengal	Kolkata as % of WB
1	Energy Requirement (in MU)	18765	63.247	29.67
2	Peak Demand (in MU)	3141	10714	29.32
3	Population (2011 census)	14112536	91276115	15.46
4	Area (in sq km)	1886.67	88752	2.13

Figure 11: Comparison of Kolkata with West Bengal Power Scenario in 2018-19

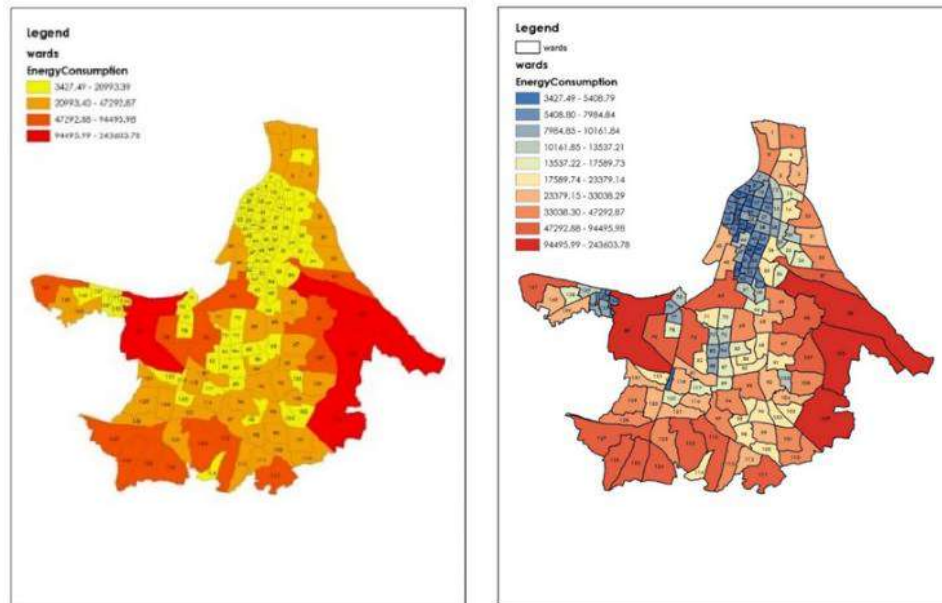


Figure 12: Energy Consumption of Kolkata Ward Wise on 2021 Figure: Zonal Analysis of Energy Consumption of Kolkata Ward Wise on 2021

4.9 Detailed Analysis:

The Detailed Analysis was done by taking up the Independent Variable as Energy Consumption based on the data gathered ward wise where it was co-related with the various dependent variables that were taken in association with urbanization ward-wise, where the R-Value was derived along with a correlation graph separately for each variable with respect to energy consumption. Hence the relationship that was derived shows the nature of its dependency and its effect on the energy consumption data. The Spatial Regression map of each dependent variable was generated showing which wards are highly correlated and highly uncorrelated.

So, the Population Density shows a high correlation between Electricity Consumption and Population Density. Huge population pressure due to migration from the whole of Eastern India has led to excessive urbanization and hence an increase in Population Density in KMC. The R-value shows a positive correlation between Electricity Consumption and Household Density. Due to huge Migration and increase in the Residential and Industrial the household density increases in the wards. The R-value shows a low Correlation between Electricity Consumption and NDVI. An increase in Urbanization meant an increase in built-up therefore the green patches reduced drastically. Hence higher the consumption lesser the NDVI. The R-value shows a positive correlation between Electricity Consumption and the Normalized Difference Built Index. The ward with more residential and built-up shows more NDBI and hence the increase in energy consumption is higher. The R-value shows a positive correlation between Electricity Consumption and Co2 emission Intensity. As the city experienced urbanization therefore the population along with other parameters caused an increase in CO2 emission. The R-value shows a positive correlation between Electricity Consumption and Land Surface Temperature. Due to globalization and an increase in urbanization resulting in built-up, the city has experienced higher LST and thus resulting in increased consumption of Energy.

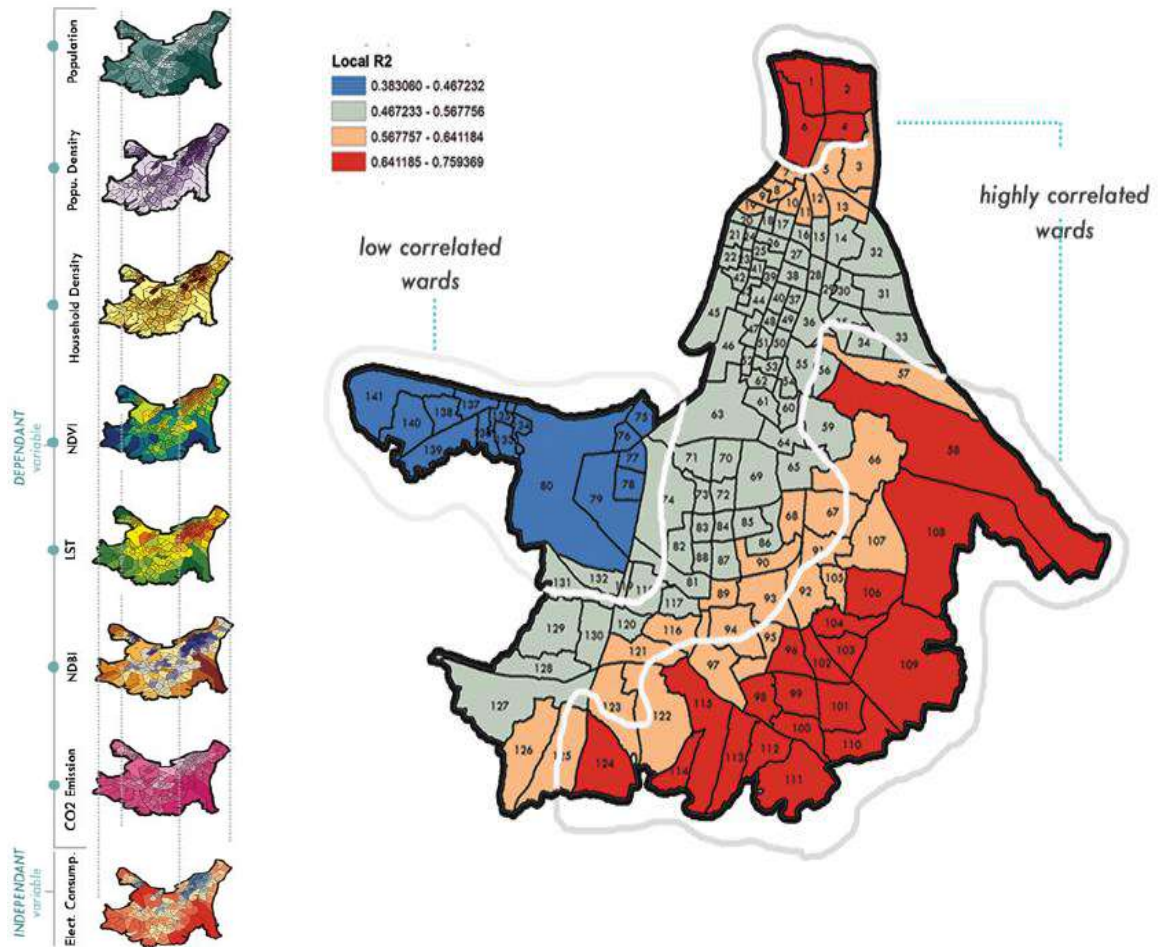


Figure 13: Spatial Auto Correlation Map

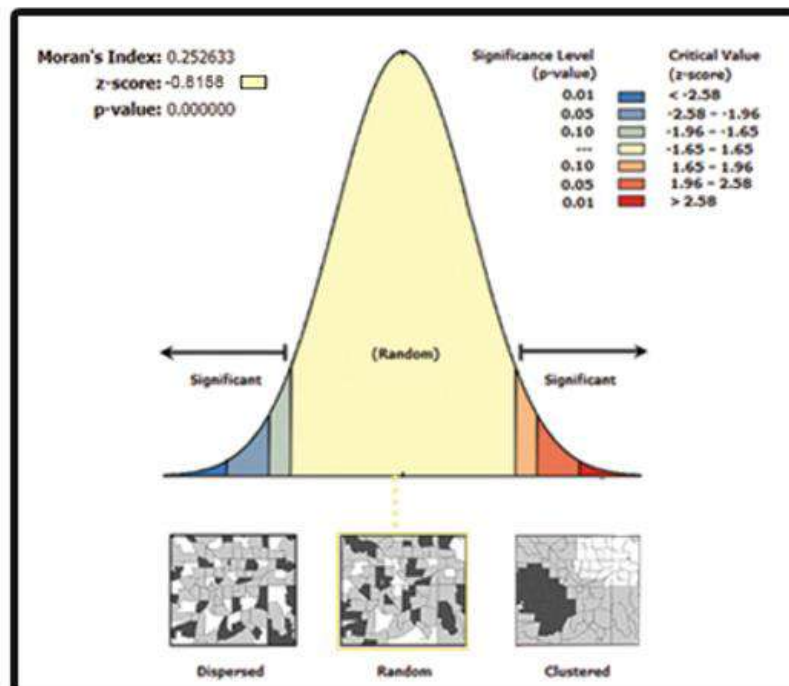


Figure 14: Spatial Auto Correlation Moran's Curve

Source: Compiled by Researcher

The spatial Autocorrelation Moran Curve shows Yellow which means the Random. Therefore, the Regression method further selected was the Ordinary Least Square Method Spatially representing the values, it was observed that the ward with a high population and more land surface temperature have high correlations. The south-eastern fringes of Kolkata are observed to be highly correlated due to urban expansion on that part of the city and the ward that was low correlated because of less built-up and near to Hooghly River.

4.10 Ordinary Least Square:

After performing the Spatial Auto Correlation on the Analysis taking Electricity consumption as an independent variable Moran's curve report was achieved at which the result showed yellow that is random. Hence, the method chosen was the Ordinary Least Square method which was done using the SPSS model where the data was inputted, and hence the report was achieved and hence it was shown spatially to locate the highly correlated and uncorrelated wards.

1 Descriptive Statistics			
	Mean	Std. Deviation	N
Population	31891	14252	141
Population Density	411	256	141
Household Density	157	63	141
NDBI	75	9	141
LST	75	1	141
NDVI	0	0	141
CO2 Consumption	839571	481999	141
Road Density	261	36	141

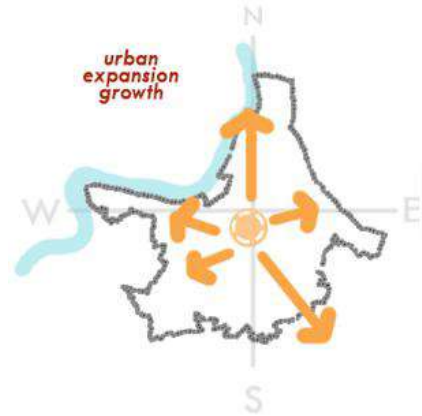
2 Correlations							
		Population	Population Density	NDBI	LST	NDVI	CO2 Consumption
Population	Pearson Correlation	1	-.208	0.069	-0.096	-0.165	0.089
	Sig. (2-tailed)		0.014	0.417	0.257	0.051	0.292
	N	141	141	141	141	141	141
Pop_Density	Pearson Correlation	-.208	1	0.049	-.237	0.100	-.445
	Sig. (2-tailed)	0.014		0.585	0.005	0.240	0.000
	N	141	141	141	141	141	141
NDBI	Pearson Correlation	0.069	0.049	1	0.069	-0.038	-0.043
	Sig. (2-tailed)	0.417	0.585		0.416	0.654	0.612
	N	141	141	141	141	141	141
LST	Pearson Correlation	-0.096	-.237	0.069	1	-.191	-.432
	Sig. (2-tailed)	0.257	0.005	0.416		0.023	0.000
	N	141	141	141	141	141	141
NDVI	Pearson Correlation	-0.165	0.100	-0.038	-.191	1	0.059
	Sig. (2-tailed)	0.051	0.240	0.654	0.023		0.484
	N	141	141	141	141	141	141
CO2 Consumption	Pearson Correlation	0.089	-.445	-0.043	-.432	0.059	1
	Sig. (2-tailed)	0.292	0.000	0.612	0.000	0.484	
	N	141	141	141	141	141	141

3 ANOVA^a					
		Sum of Squares	df	Mean Square	Sig.
1	Regression	83527295384	6	13921215897	27
	Residual	69976589775	134	522213357	
	Total	153503885159	140		

4 Coefficients^a						
Model		Unstandardized Coefficients	Std. Error	Standardized Coefficients	t	Sig.
		B		Beta		
1	(Constant)	-22119	140246		0	1
	Population	1	0	1	8	0
	Pop_Density	-60	8	0	-8	0
	NDBI	-46	222	0	0	1
	LST	432	1844	0	0	1
	NDVI	24420	22031	0	1	0
	CO2_Consumption	0	0	0	0	1

4.11 Directional Analysis:

As a result, it was found from the directional analysis that through the time slices from 1993 to 2003 to 2016, the directional growth is in the northern part of the KMC boundary. However, due to the northern part of Kolkata being the oldest part of civilization where the growth started, in recent years as there is no longer any space to grow, the growth of Kolkata is shifting to the southern part, especially the eastern part due to land. According to KMA-rural, between 2006 and 2016 there was a greater decrease in the change in the value of entropy for both groups than between 1996 and 2006. The entropy values for KMA-rural were found to be much higher and closer to their corresponding $\log(n)$ than for KMA-urban when the built-up class was compared between KMA-urban and KMA-rural. According to the study, the existing built-up cover has been compacted as a result of built-up infill, which has caused a decrease in the rate of built-up growth dispersion in KMA-urban over time. The rate of dispersion in KMA-rural was still quite high compared to KMA-urban. This suggests that the rural parts of the KMA were expanding at a faster rate, with leapfrogging and dispersed forms of built-up areas.



4.12 Comparative Analysis:

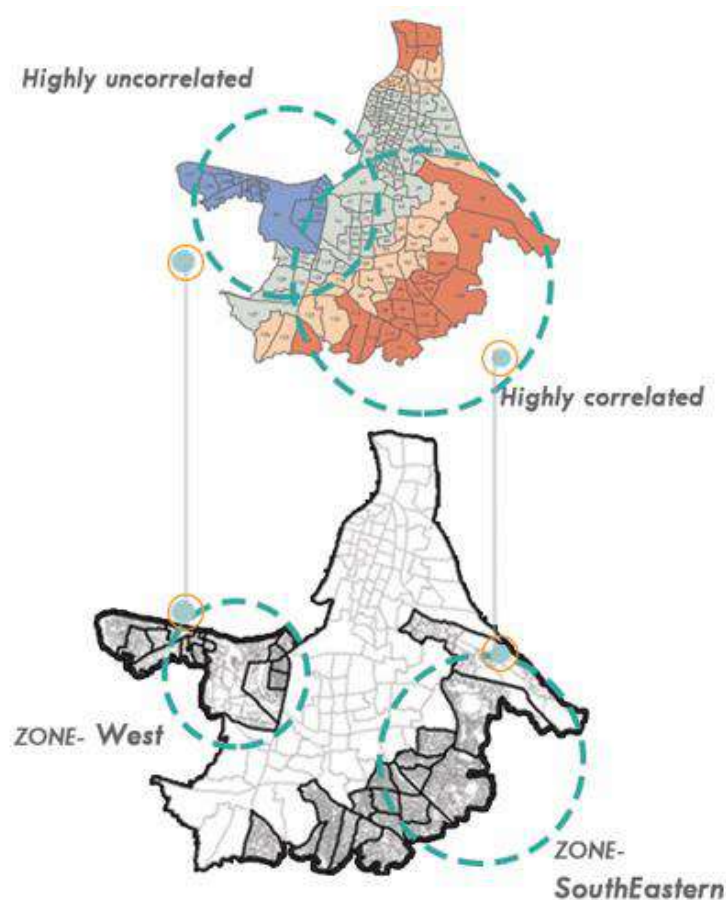


Figure 15: Energy Consumption of Kolkata Ward Wise on 2021

5. Conclusion :

Based on the aforementioned analysis of the effects of urbanization on energy demand in neighborhoods in Kolkata's peri-urban fringes over the past ten years, it was found that the built-up or residential area has grown significantly while the vegetation-covered or undeveloped areas have shrunk very quickly. In recent decades, Kolkata has rapidly developed as a result of numerous career opportunities, top-notch healthcare, etc. Due to the northern part of Kolkata being the oldest part of civilization and where growth began, it was observed from directional analysis that through the time slices from 1993 to 2003 to 2016 that the directional growth is in the northern part of the KMC boundary. However, in recent years as there has been no more space to grow, the growth of Kolkata has shifted to the southern part especially the eastern part due to land. According to the study, the existing built-up cover has been compressed as a result of the built-up infill, which has caused a decrease in the pace of built-up growth in KMA-urban over time. The rate of dispersion in KMA-rural was still quite high compared to KMA-urban. This shows that built-up settlements were spreading out in dispersed and leapfrogging ways in the rural portions of the KMA. As discovered through the examination of the satellite photos, Kolkata city has been expanding in both a south-easterly and south-westerly direction from the city core area. The demand for land in Kolkata city is very high in recent decades. From the overview of the analysis, it has been found that the temperature of Kolkata city has been increasing very fast.

In the city's core or in the center, the temperature is high. It has been determined from field verification that the majority of the agricultural fields, vegetation areas, and water body areas have been transformed into urban regions or built-up areas. Because land is so readily available there, the conversion of non-urban or semi-urban areas to urban areas occurs there more frequently than in metropolitan areas. Another reason for the quick land change in Kolkata city is the low cost of land. In the outer periphery areas, there are several instances where the urban area encroaches upon the vegetated area. On the other side, Kolkata's outer suburbs have a higher NDBI score than the inner city. To minimize these problems city authorities should take immediate measures.

The city authorities as well as those who make decisions and design policies would benefit from this research work in the creation of new regulations. This study, which was conducted in Kolkata, India, can also be done in any other Indian city. This study will shed new insight into research on urban heat islands. The results would give initiatives that try to direct more efficient energy consumption in urban areas an economic justification. For example, progressive rates levied on carbon tax (Lan & Zhan, 2017) encourage companies to use natural gas, which is more efficient in producing energy, rather than burning coal, also taking anthropogenic heat reduction measures, Greening measures, and various planning proposals implementation should be done towards the expanding peri-urban fringes to control the expansion of built up along with the green space management.

6. Recommendation :

The city of Kolkata has experienced a rapid rise in temperature. Urban planners should develop policies for temperature reduction in order to reduce these issues. To stop the unauthorized or illegal conversion of land, legislators should create new laws or regulations. To tackle this issue, there should be greater public awareness. The city of Kolkata lacks a master plan. A new master plan needs to be created in order to reduce this issue. The lack of cooperation among the developmental agencies is another obvious fact (Like KMDA, KMC, KIT, etc.). To solve this issue, there needs to be better agency coordination.

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Public Toilets, Indian Women and Urban Planning – The case of Pune

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Abstract: Public toilets in India, for women specifically, are often unsanitary, with long wait lines seen outside, due to external, demographic and biological factors. The absence/poor public toilets often result in the reduction of women's visibility and mobility in public spaces, forcing them to stay at home. Planning and allocation of toilets is one of the basic tenets of urban planning. Toilets are valuable townscape features in their own right as they add to the quality and viability of an area. India's current public sanitation framework is woefully incapable of handling the changing urban demographics and lacks inclusivity. In order to better understand the state of affairs, the author conducted a survey on a 5-point rating scale through an anonymous Google form to gauge India's current public sanitation situation. The sample size of this survey is 100 urban women and how the public toilet experience has affected them. Additionally, to further recognize women's needs, demands and expectations, image surveying and documentation of two public toilets in the Kothrud area were done. To conclude, the author has offered relevant construction and user-friendly guidelines for the same.

Keywords: Spatial planning, sanitation, hygiene, poor living conditions, health.

1. Introduction:

Planning and allocating toilets are one of the basic tenets of urban planning. Toilets are valuable townscape features in their own right as they add to the quality and viability of an area. India's current public sanitation framework is woefully incapable of handling the changing urban demographics and lacks inclusivity. Their absence often results in the reduction of women's visibility and mobility in public spaces, thus forcing them to stay at home. Through this study, we seek to better understand how the lack of foresight by city planners with respect to public toilets has a direct effect on women's mobility.

2. Literature Review:

For most people, going to the toilet in a normal situation is routine and instinctual. However, for many women, using an unfamiliar public toilet is not always easy. Despite having the desire to urinate, many will delay using the restroom when they are away from home, which can lead to urinary dysfunction and poor bladder health (Hartigan 2020). The public toilet, conceived of as a series of walled enclosures nested inside a larger enclosure, purportedly accomplishes this objective with a "hygienic imagination": by dividing "clean" public space from the "dirty" realm of the abject body (Cavanagh 2010). Therefore, a range of negative emotional reactions such as embarrassment, disgust, fear, and anxiety might appear when using a public toilet. In a recent survey, some of the observations on the condition of public toilets in India for women have been discussed (Chandra 2019). Today in Pune

(Zone1) there are 64 toilet seats for women in Kothrud and 48 in Warje, with 6 urinals (PMC 2016). This research paper attempts to understand public toilets by dividing it into several parameters.

3. Methodology:

3.1. Online questionnaire and Image Surveying - The format used in the online questionnaire was to better understand the user experience in detail, specifically that of women. It is still considered taboo to talk about such topics which made it necessary to make the questions anonymous for those who didn't feel comfortable sharing their personal details. The sample size of this research paper is 100 women from various backgrounds in Pune city. As seen in the pie chart below (Figure 1), the majority of women in this survey were in the age group of 18-25, 26-50 and 51-65 and the next chart (Figure 2) states the professional status of most women in the sample group. This questionnaire will be key to understanding women's needs, demands and expectations regarding public toilets. The need for water in public restrooms, street lighting in and around public restrooms, taboos around menstruation and sexual harassment, the cost of using public restrooms, and the availability of sanitary napkins in public restrooms were listed as top priorities. It is important to note that the sample size taken here may not represent the needs of all women. Additionally, image surveying of two public toilets was done in Kothrud for visualizing all the amenities that were found lacking and to better represent the appropriate interventions that ought to be implemented.

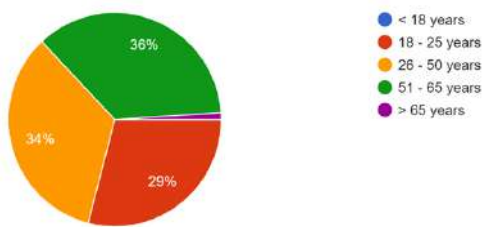


Figure 1: Age demography

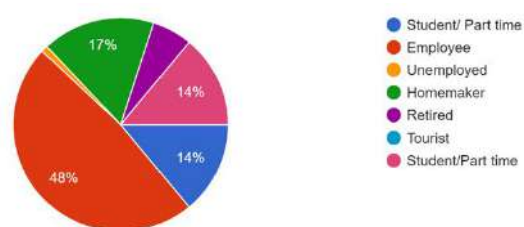


Figure 2: Professional status

The age group that mostly responded to this questionnaire is in the age group of 26-50 with most of them being employees and being one of the main user groups in using public toilets. It is also important to note that most toilets are not senior citizen and disability friendly when they simply consist of squat toilets. This kind of non-inclusive architecture can lead to many people being left out and, in a position, where they may not be able to step out of their homes independently.

3.2. Data Survey



Figure 3: Map of Kothrud



Figure 4: Mrutyunjay Temple



Figure 5: Dahanukar Colony

4. Analysis:

This research is aimed to find out the current issues and conditions of public toilets vis a vis several parameters. This is the roadmap of the analysis:

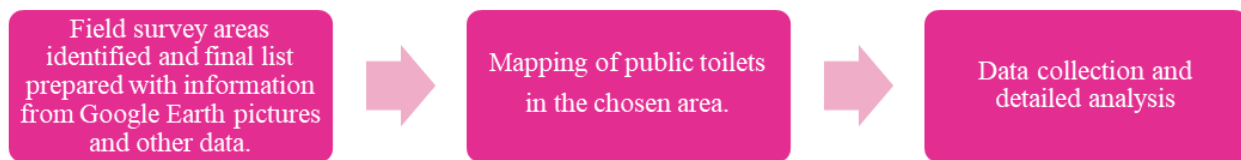


Figure 6: Roadmap

The research first started by conducting a survey of 100 women to know the current condition of Indian toilets. Then deciding on a particular area, in this case, Kothrud, which is a major residential area located in the heart of the city. After mapping the two chosen public toilets, image surveying and appropriate documentation were done with a detailed analysis of their pros and cons, including relevant guidelines for the construction of ideal toilets.

4.1. Location of public toilets:

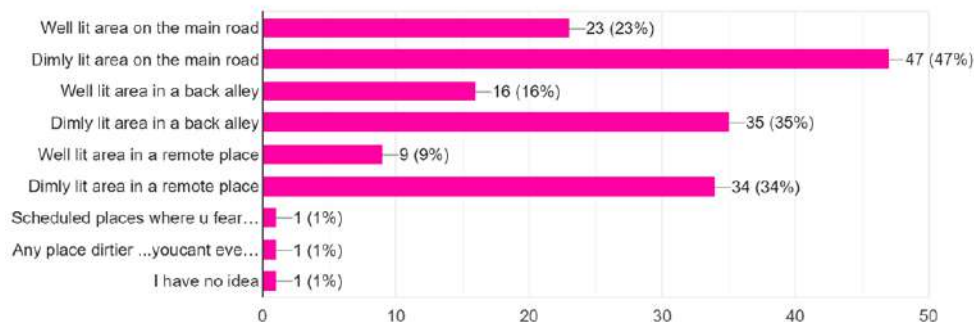


Figure 7: Location

As shown in Figure 7, almost 50% of public toilets are located in dimly lit areas on the main road and 35% in a dimly lit area in a back alley. With most public toilets in dimly lit areas, most women do not

feel comfortable entering such spaces, especially at night. The main reasons that women felt uncomfortable late in the night was due to the comments, glances, and other forms of subtle harassment from men. These nuances are not captured by surveillance, but other forms of abuse can be facilitated by the usage of CCTVs (Ramster 2006). The location of toilets is crucial and should ideally be situated on the main road whilst also maintaining the safety and privacy of the users. It is crucial to maintain a balance of natural discretion without inducing feelings of fear and isolation.

4.2. Frequency of using public toilets :

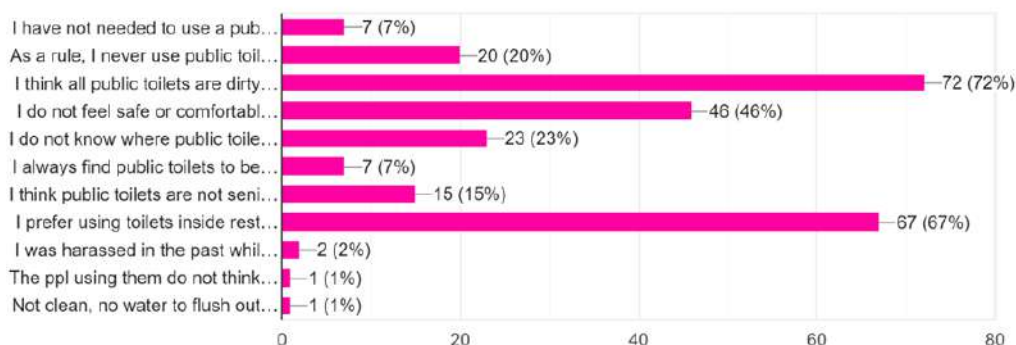


Figure 8: Usage

A recent study highlighted the fact that women's washrooms often have longer lines and queues (Pinsker 2019). This disparity appears for a variety of reasons. The existence of fewer restrooms overall for women than for males is one reason why the wait time is longer. This is due to the fact that the whole surface area is frequently distributed similarly, although a toilet cabin invariably requires more room than a urinal. Men can fit 20% to 30% more toilets (urinals + cabins) in an average toilet area than women.

Caste, class and economic status also play a big role. While the people from the privileged sections of society can access free washrooms in business establishments like cafes and malls, most workers are not even allowed to enter these premises. According to a study, most women who use public restrooms are usually from financially weaker sections of society. Thus, we see most of them using it, which creates long lines outside washrooms (Pinsker 2019).

Men take 60 seconds to use a toilet, whereas women take 90. This is a 50% increase in the time spent in the toilet. In addition, men's restrooms have multiple urinals which do not need the opening and closing of doors twice. This is created due to the cumbersome nature of women's clothing and a higher risk of STDs which forces women to spend a longer time in restrooms (Reddy 2017).

Safety of women is also a major issue plaguing public toilets. An article (Khanna, Puthran 2020) states that public toilets in India often charge Rs 5-10 for using toilets but they are poorly maintained and women living on pavements who are completely dependent on these toilets cannot afford to use them, which forces them to relieve themselves in open empty plots. This leaves them vulnerable to exposing themselves and even being harassed by men. Another point that the article highlighted was the poor maintenance of these toilets. There are many men who loiter around women's washrooms to peek and there have been many cases of all their windows being broken. This makes a lot of women apprehensive of using public toilets, since there is a risk of harassment and shame associated with it. We can confirm this from the above graph which states that 2% of women face harassment for using restrooms. According to the Pune Public Toilet Policy (PMC 2017), there needs to be a lady caretaker in all women's washrooms. A lady caretaker has to be certified and qualified for her tasks and is supposed to wear a

uniform during working hours, in addition to carrying a photo identity card at all times. But from our survey, it's clear that public toilets are almost always abandoned and neglected.

4.3. Effects of public toilets on women's health:

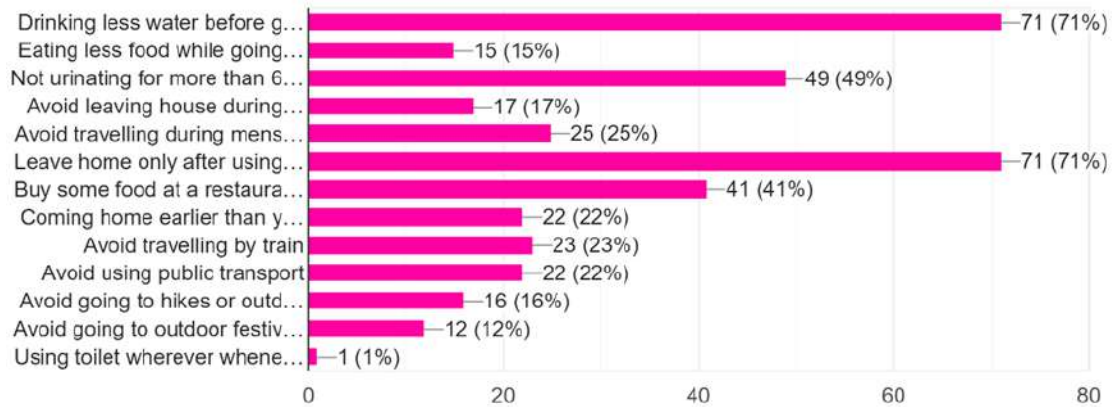


Figure 9: Effects

From Figure 9, it is clear that women actively avoid going to public restrooms and even take extreme measures like not drinking enough food and water for the same. These make up 71% of all answers. Not drinking enough can lead to dehydration, dizziness, malnutrition and deficiencies of all sorts. This trend ends up compromising women's health, and has the eventual effect of a loss of their presence in public spaces. Women are also at a higher risk of STDs since there is a possibility of skin coming in contact with the toilet seat.

4.4. Overall physical condition of public toilets:

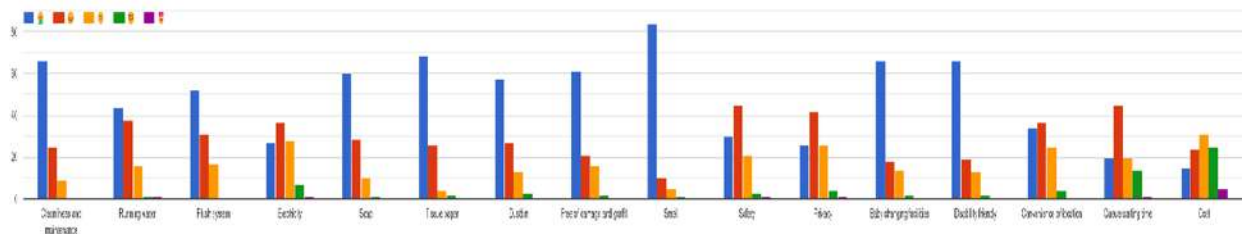


Figure 10: Overall condition

It is clear from Figure 10 that public toilets in Pune are not properly maintained, with almost all parameters performing extremely poorly. These toilets often do not have proper soaps and water supply, erratic electricity supply and a constant dearth of tissue paper, sanitary pad dispensers and dustbins. The worst performing parameter is smell with more than 90% of people being disgusted by it. The only parameter doing better is the cost aspect but it is important to remember that even if the cost of using these toilets is meager, they are not cleaned properly or they are completely neglected. Also, a key point to note would be to remember that this questionnaire was attempted by women from predominantly good financial backgrounds. Hence, paying for using a toilet may not be affordable to everyone, especially since the majority of public toilet users are women from financially weaker sections of society.

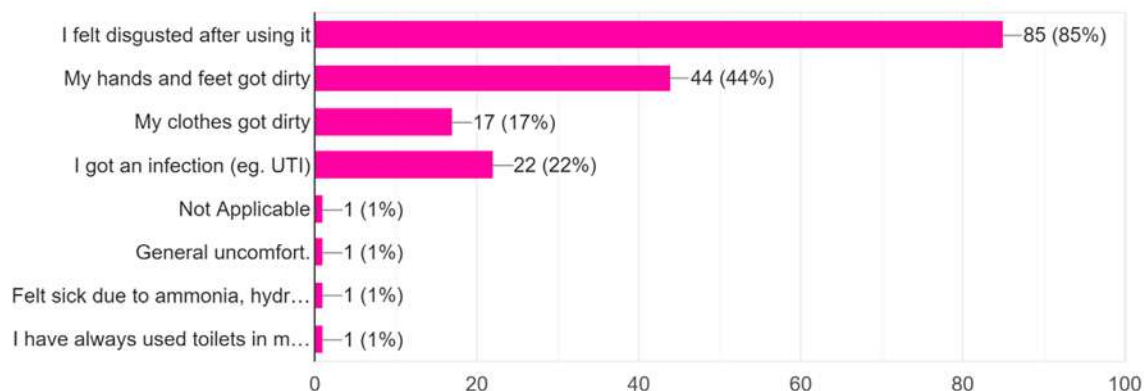


Figure 11: Experiences

5. Discussions:

From the above data collection and analysis, it is clear that the state of Indian public toilets is abysmal with the majority of women going to extreme lengths to avoid using them. The risk of sexually transmitted infections, safety and privacy are some of the main reasons. Improper or lack of proper washroom equipment is also a major issue that most women face. Though governments and policy makers emphasize women's involvement in sanitation programs, socio-cultural factors, community and household-level dynamics often prevent women from participating in sanitation-related decisions. Measures are needed for strengthening sanitation policies and the effective implementation of programs to address gender power relations and familial relationships that influence latrine adoption and use. The following framework suggests the following (PMC 2016):

Table 1: Ideal toilet framework

EQUITABLE USE- The design must be useful and marketable for diverse abilities.	FLEXIBILITY IN USE- The design accommodates a wide range of individual preferences and abilities.
SIMPLE INTUITIVE USE- Design should be easy to use regardless of the user's knowledge.	PERCEPTIBLE INFORMATION- The design communicates necessary information to the user, regardless of the ambient conditions or the user's sensory abilities.
TOLERANCE FOR ERROR- The design minimizes hazards and the adverse consequences of accidental actions.	LOW PHYSICAL EFFORT- The design enables efficient and comfortable use with no fatigue.
SIZE AND SPACE OF APPROACH- Appropriate size and space are provided for approach, reach, manipulation and use regardless of the user's size.	SOCIAL INTERROGATION- Treating all groups with dignity and respect and reinforcing positive cultural values.

The guidelines also include a list of mandatory elements in public toilets the table below shows the same (PMC 2016):

Table 2: Additional guidelines

	Option 1	Option 2
Optimal Ventilation	Natural and Passive Ventilation	Ventilation via exhaust
Optimal Lighting (Internal and External)	Natural light in the day and optimal light at night	Optimal lights during day and night
Differently abled and elderly-friendly accessories	Western-style commode with grab handles and bars	Indian WC with grab bars
Waste Management	Individual toilets in women's restrooms for menstrual waste management	Dustbins in male toilets
Plumbing arrangement for post-use cleaning	Health faucet	Tap and Mug system
Systems for fee collection	Operator for a toilet without automatic coin system	Automatic coin system for unmanned system

**Figure 12: SBM toilet near Mrutyunjay Temple**

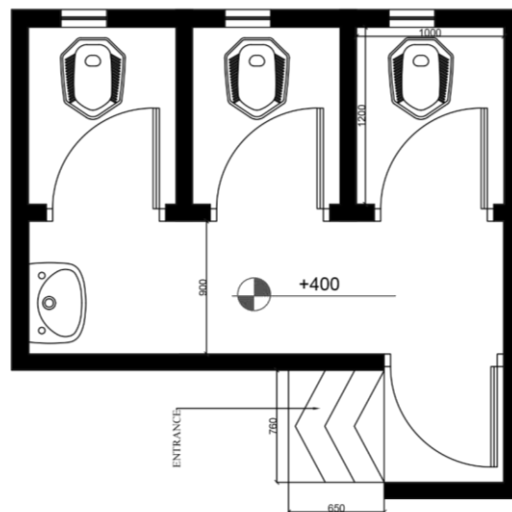


Figure 13: Drafted toilet of SBM Mrutyunjay Temple (Scale 1:30)

This Swachh Bharat Mission toilet near Mrutyunjay Temple was not well kept and had a bad odour emanating from it that could be smelt even a few meters from it. This toilet was also not cleaned properly as seen in Figure 12. It had a caretaker looking after this toilet but was quite hostile towards any questions asked. It is important to note that though there was a slope given for wheelchair users but it was too steep, uncomfortable and unusable for wheelchair users.



Figure 14: SBM toilet near Dahanukar colony

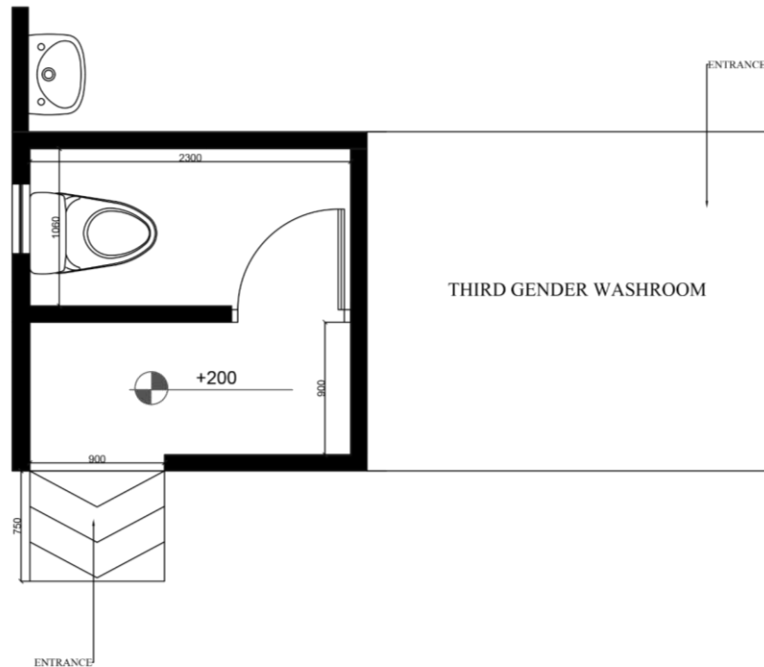


Figure 15 : Drafted toilet of SBM Dahanukar Colony (Scale 1:30)

The Dahanukar Colony toilet was a lot cleaner and well maintained with no odour and even provisions for the third gender as seen in Figure 15. While there was a bucket provided for cleaning inside the cubicle, the wash basin was on the other side which could be embarrassing for many women. We can conclude that with proper water supply and proper positioning of sanitaryware, we can significantly improve the user experience.

6. Suggestions:

6.1. More toilets to be made available in the community, especially for girls and women. More public toilets for women should be built, as the number of toilets for men and women are not proportionate and nor are they adhering to the provisions mentioned in the guideline (SBM 2017).

6.2. Community toilets and public toilets should be well maintained and have all the necessary amenities like proper lighting, running water, sanitary pads, soaps, proper doors and covered windows, disposal mechanism and many such essential facilities.

6.3. Increase in public financing to push for more women-only community toilets, and water and sanitation services. Integrating gender perspective and sensibilities into urban planning, infrastructure design, planning and implementation is essential for catering to the needs and demands of young urban women in low-income communities.

6.4. Creating inclusive public systems and policies to ensure the benefit of services reaches people from different castes, classes and religious backgrounds

6.5. Initiatives to build awareness and orientation on community, state and center level with various government and non-government officials on linkages between social, economic, and political participation and freedom of women and utilization of public services.

6.6. Build networks with allies and like-minded formal and informal groups to strengthen linkages between public service systems and security, safety and prevention of violence against women.

7. Conclusion: Through the above discussions, analysis and suggestions, we can conclude that there still is a long way for public toilets to be inclusive. But small and collective steps are key to steady progress. With proper guidance and references from community and corporation guidelines we can make our society safer and more secure for women.

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Effects on land use transformation of urban frontier due to fringe area quantum leap- A case of Wardha city

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Abstract:

The conversion of Earth's land surface to urban uses is one of the most irreversible human impacts on the global biosphere (Seto KC), 2011. With rapid urbanization and industrialization across the globe, urban and rural planning-related problems are increasing especially in the Rural-urban interface. The urban age is not just beginning in cities; suburban villages are also being impacted by this worldwide phenomena. As a result of this trend, peri-urban areas have grown. These regions are dealing with significant issues and dynamics for planning and implementing land use transition that was formerly dominated by agriculture.

Further research on the rural-urban interface is crucial since peri-urban areas in major cities are expanding quickly. A sustainable Municipal city also depends on the planned growth of its fringe areas. Thus, it is important to encourage the planned and sustainable urbanization of peri-urban areas. The population under migration is located on cheap land. Densification of the peri-urban area may help the central city's congestion. Additionally, it might be a solution for urban slums. For appropriate and efficient land use we need to study peri urban areas, the small settlements at the rural urban fringe usually are shifted when the development starts (Ar. Manita Saxena).

As a result, this study focuses on examining how land use transformation is affected by spatial changes in a dynamic rural-urban interface. This paper aims to understand the existing land use pattern, composition, and land cover categories in peri-urban areas. This research intends to recognize the main trends and drivers influencing urban borders and rural change and to comprehend the main issues that arise in the rural-urban interface and to identify solutions using sustainable planning principles (A. R.-G.-S.-C.-G.-O.-C. R. Rojas-Caldelas).

The study took advantage of satellite imagery to generate a LULC 3 map for the Peri-Urban area of Wardha city at decadal intervals. Polygons were traced where LULC change has happened by superimposing Landsat pictures on top of each other. The mapped data was evaluated using picture interpretation on-screen. This spatial data analysis was carried out with the help of the ArcGIS tool.

Keywords: Urban Frontiers, Rural Transformation, Peri-Urban, Spatial Analysis, LULC

1. Introduction:

1.1. Background

Urban and rural planning-related issues are getting worse, particularly in the rural-urban interface, as a result of the world's fast industrialization and urbanization. The study "Urban Frontiers and Rural Transformation" focuses on examining how social and physical changes in dynamic rural regions are causing this move from a rural to an urban system. This study also focuses on analysing how spatial changes in a dynamic rural-urban interface affect land use transition. Understanding land use change trends and taking the required steps to lessen its detrimental effects on the city and its surrounding area will be made possible by decades of LULC research. The research paper will also discuss the subject's key concepts, theories, and ideas.

1.2. Urban frontiers and rural transformation

"Urban frontier" refers to spaces in or around a city in which resettlement and new forms of economic development are emerging, often as a result of incoming capital investment associated with an often racialized political struggle between long-standing and newly settled residents (BURT).

"Rural transformation" is a process of change in rural regions that is dependent on a variety of variables and processes. In general, it has been described as modernization, rural development, changes in economic structure, and the movement of people from the farming sector to non-farming sectors of the economy.

Transformation from rural to urban system: The urban age is not just beginning in cities; suburban villages are also being impacted by this worldwide phenomena. In nations around the world, the connection between urban and rural areas is shifting. Other components of the process are particular to certain nations or locations, while other of the problems, like shifting agricultural systems, are universal. As a result of this trend, periurban areas have grown. For the planning and implementation of land use reform, these areas are dealing with significant issues and dynamism.

1.2.1. Effect of social and spatial transformations

As new types of urban, suburban, and exurban development affect community development patterns, migration and settlement patterns are shifting. Conflicts over land use and lifestyle caused by much of this development take place in peri-urban areas that were formerly predominately agricultural. Many policies like AMRUT and SPMRM continue to focus exclusively on rural or urban areas and fail to address the connections between the two. Secondary schools, post offices, telephones, credit, services for agricultural expansion, farm equipment, hospitals, and government services are all dependent on urban regions for rural areas. Both rural and urban populations benefit from strong connections in terms of living circumstances and work prospects. The success of the interaction between urban and rural areas rests on domestic trade, adequate infrastructure, and infrastructure that is both cost-effective and effective.

1.3. Need of the Study

Inadequate infrastructure, a low degree of economic activity, and poor land use planning are some of the fundamental issues caused by peri-urban growth. People frequently have issues with moving, buying land, encroachment, substandard living in slums, psychological breakdowns, problems with the law and order, the lack of a political structure, and social and environmental issues. All the factors leads to the creation of a 'degenerated periphery'. Many policies continue to focus exclusively on rural or urban areas and fail to address the connections between the two.

In order to promote inclusive, mutually beneficial, and sustainable urbanisation, rural stakeholders must be involved. Only when cities are surrounded by prosperous rural areas, particularly those with a resilient, fruitful, and lucrative agricultural industry, can cities be sustained. Thus, it is important to encourage the planned and sustainable urbanization of peri-urban areas.

2. Study Area and Data Collection

2.1. Selection of Study Area

The study area is Wardha City located between 20°44'30"N and 78°36'20"E, with a total area of approximately 75 km² (7500 Ha) and an altitude of 234 m in Maharashtra State. Wardha is a municipal council in the Central Indian state of Maharashtra, which gets its name from the River Wardha. As per provisional reports of Census India, the population of Wardha Municipal Council (WMC) and 7 more Census towns around the city area in 2011 is 2,12,602; of which WMC population is 106,444. Wardha's average temperature is about 28°C, however it can range from about 21°C in the winter (December) to about 37°C in the summer (May). May has the highest average temperature of the year, ranging from 30.4°C to 44.4°C. December is the coldest month of the year, with ranges from 11.9°C to 27.8°C.

Table 1 Census towns around wardha city and their population

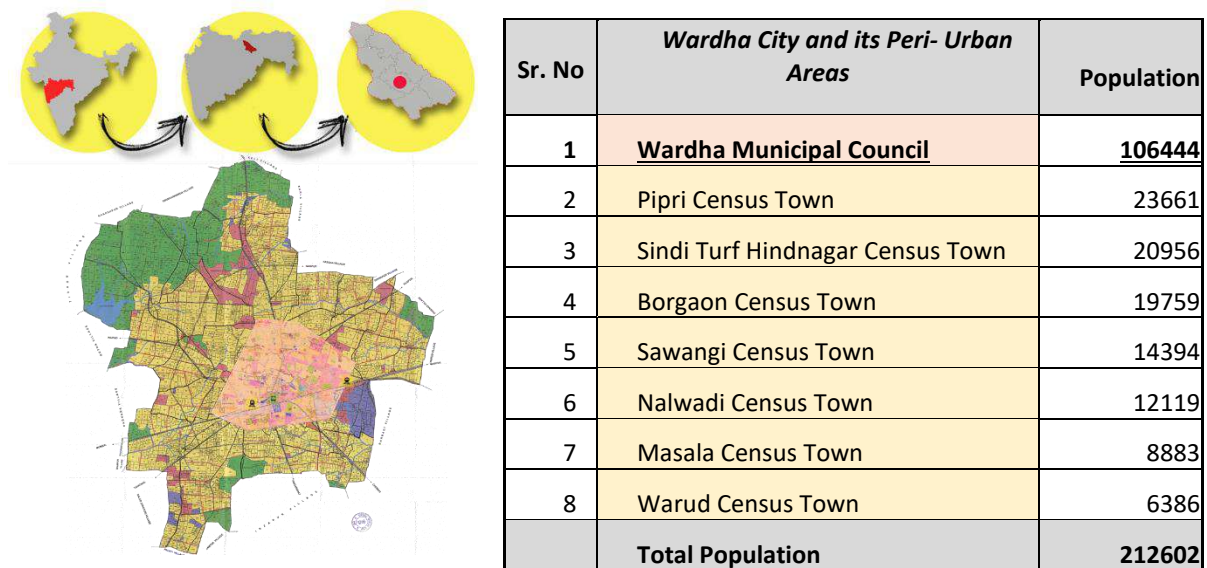


Figure 1: The geographical location of the study area

2.2. Data Collection

In this study, the influence of peri-urban areas' changing land use and cover over a ten-year period is discussed. The USGS Earth Explorer website allows users to download Landsat satellite photos. Zone 44N for Landsat 8 OLI-TRIS for WGS 84 Date: 01.02.2011 is gathered. Image has sensors called Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS). Landsat 5 MSS for WGS 84, Zone 44N, Date: 03-Feb-2022 is collected. Image has sensors called Multispectral Scanner System. Here, the spatial resolution of the Landsat 8 satellite is 30 m, so each band pixel is multiplied by 30 m X 30 m to get area covered, while the spatial resolution of the Landsat 5 satellite is 60 m, so each band pixel is multiplied by 60 m X 60 m to get area covered. The location, shape, and properties of geographic features are stored in shape files, a vector data storage format developed by Esri.

Table 2: List of the Landsat data used

Seasons	Year	Satellite	Date of acquisition
Winter	2022	Landsat- 8	2022/02/01
Winter	2011	Landsat- 5	2011/02/03

3. Methodology :

Each image was downloaded as a WRS tile and includes information in 7 distinct bands. A layer stack of these 7 band pictures is required to construct a land use map, and once that layer stack has been completed, an administrative boundary for the city of Wardha was added. Land use maps are classified using 'Interactive Supervised Image Classification' techniques. Present study focuses mainly on four land use class i.e. Barren Land, Urban Area, Water body and Vegetation.

Table 3: LULC Classes

Sr. No.	Land Cover Class	Description
1.	Barren Land	Fallow Land Arid or poorly vegetated regions that most frequently feature bare ground or soil
2.	Urban Area	Includes all construction in the commercial, residential, Public and industrial sectors.
3.	Water Body	All bodies of water, including marine habitats as well as freshwater lakes, rivers, and streams.
4.	Vegetation	Agricultural grasslands, recreational greens and all sorts of forest vegetation, including dense forest and open forest.

Detail methodology followed to generate LULC for 2011 & 2022 is as follow:

Step1- Download landsat data from USGS website of the study area in terms of 7 bands and import those band in GIS platform. Use Composite tool from Data Management tool set to create a composite file of all the 7 bands combined. Natural Colour – 432.

Step2- Open Image Classification toolbar from customize ribbon to perform image classification on composite file. Open Training sample manager, and use draw polygon tool to select pixel values on the map of different areas for 4 aspects i.e. for Barren Land, Urban Area, Water Body & Vegetation.

Step3- Select 10 or more samples of each pixel value from the map with the help of different false colour composition. Then merge the sample points by using Merge training samples and create samples for each aspect.

Step4- After creating all samples use Interactive Supervised Classification Tool from Image Classification toolbar to generate LULC. Select a study area by creating a polygon shape file & extract the study area from the LULC layer, by using Extract by mask tool or clip tool. Now convert the raster result into polygon using conversion tools and calculate the areas for each class defined.

Detail methodology followed to generate change in area of each aspect.

Step1- After getting LULC map for both years 2011 and 2022 using supervise classification method raster files converted into vector files by using raster to polygon tool. Projected coordinates need to set from UTM zone for area calculation. (Wardha- 44N northern hemisphere, WGS 1984)

Step2- All the polygons from shape files categories into 4 classes using dissolve of geoprocessing tool for both shape files. Calculate areas of both shape files in new field by calculate geometry.

Step3- Create changes between years using intersect of geoprocessing tool to get 16 attributes. Now add 2 new field i.e. change and area change, for change use field (calculator change = {(class 2011) + "-" + (class 2022)},) by using this we will get 16 classification like vegetation - barren land, vegetation - urban area, etc. Then use Geometry calculator to get respective areas for each fields.

The methodological algorithm will show the LULC images as well as the percentage of the region that each of the different specified classes covers. The algorithm is applied to the colour class cluster in order to extract the feature. The resulting LULC images produced using the aforementioned process are then used for analysis.

4. Analysis :

Land use land cover map of Wardha city for 2011 and 2022 were prepared (Fig. 2) and results showed that in 2011, the area covered under Urban Area was about 7% (456 Ha); 73% (4972 Ha) Barren Land; 20% (1406 Ha) Vegetation and only 0% (17 Ha) covers under Water Bodies. Similarly, in 2022, area covered under Urban Area was about 24% (1602 Ha); 62% (4255 Ha) Barren Land; 14% (973 Ha) Vegetation and only 0% (20 Ha) covers under Water Bodies.

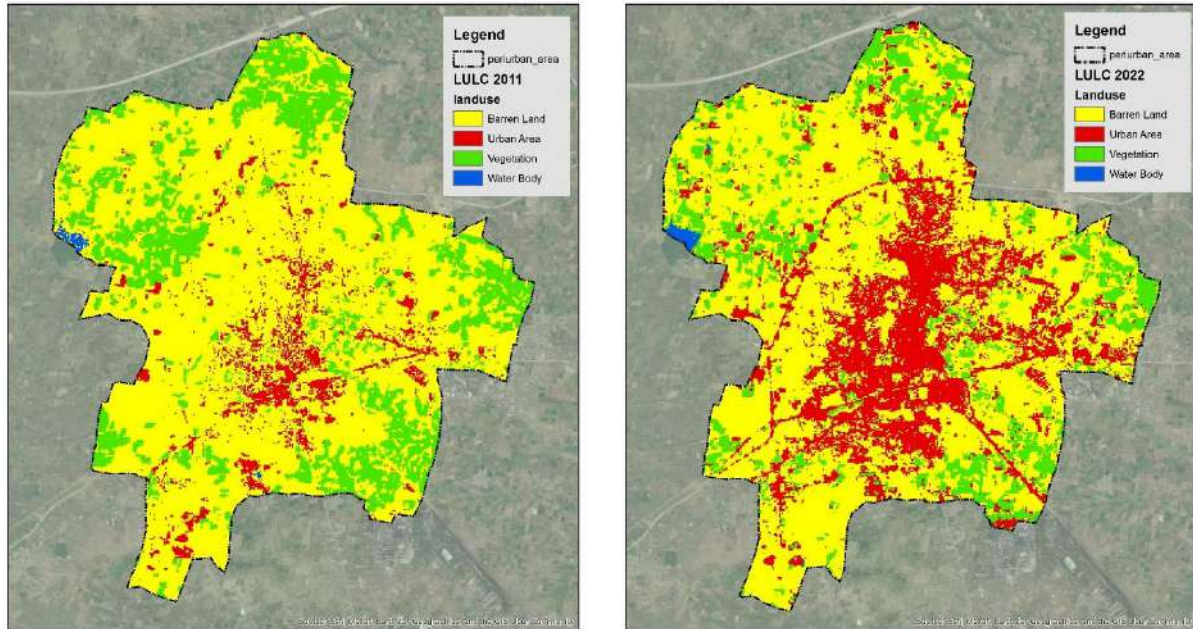


Figure 2: Land Use Land Cover Map of Wardha City 2011 & 2022

Table 4: Statistics of Landsat classification area for 2011 and 2022

Sr. No.	Land use	2011 Area in %	2011 Area in Ha.	2022 Area in %	2022 Area in Ha.	Difference In %	Difference In Area
1	Urban Area	7	456	24	1602	17	1146
2	Water body	0	17	0	20	0	3
3	Vegetation	20	1406	14	973	-6	-433
4	Barren Land	73	4972	62	4255	-11	-717

As a result, it was noted that the area covered by vegetation decreased by 6% over the ten-year period 2011–2022. Due to rapid urbanisation, particularly on the outskirts of the city, forest land has diminished as a result of deforestation and must be turned into built-up territory. As a result, the area classified as an urban area in 2022 has grown by 17% from 2011. However, it was discovered that the region that was barren in 2011 had shrunk by 11% and appeared to be replaced by a built-up area, as shown in Figure 3.

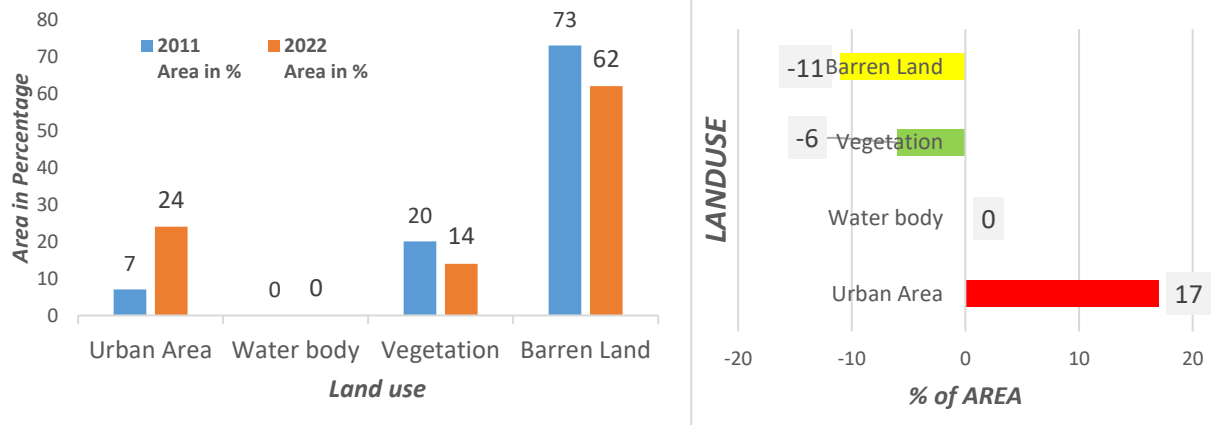


Figure 3: Percentage of different land-use/land-cover classes from 2011 to 2022

Land use land cover map of two decades was dissolved and intersect to get the change in landuse from one class to another. Final change in areas of each attribute is given in Table 4.

The processes of land-use transformation is possible in number of ways, like, Land acquisition for industrial, commercial, real-estate and infrastructure development, land acquisition for the creation of special economic zones 5 (SEZs) and selling of agriculture land by farmers for the construction of houses by individual owners. Since agriculture is less valued than other industries, some farmers "give up" land without protest as land prices increase as infrastructure and development projects are announced.

Table 5: Change in Land Use from one class to another

Sr. No.	Change (2011-2022)	Change Area in Ha.
1	Barren Land-Barren Land	3441.83
2	Barren Land-Urban Area	1164.31
3	Barren Land-Vegetation	354.08
4	Barren Land-Water body	5.68
5	Urban Area-Barren Land	116.26
6	Urban Area-Urban Area	327.23
7	Urban Area-Vegetation	12.17
8	Urban Area-Water body	0.33
9	Vegetation-Barren Land	691.15
10	Vegetation-Urban Area	108.36
11	Vegetation-Vegetation	603.59
12	Vegetation-Water body	0.18
13	Water body-Barren Land	0.21
14	Water body-Urban Area	1.05
15	Water body-Vegetation	1.72
16	Water body-Water body	13.82



Figure 3 Chart showing change in Land use of all 16 classes

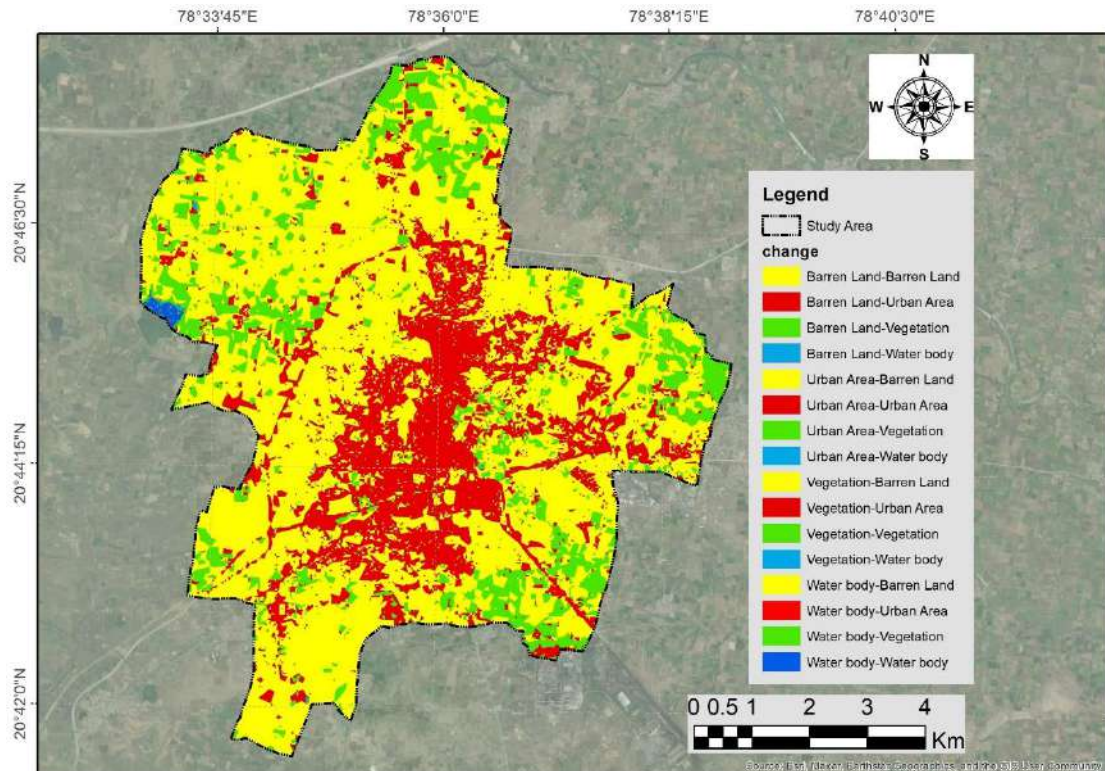


Figure 4: Change in Land Use from one class to another over the decade

The magnitude of the LULC alterations at Wardha City over a 10-year period have been discernible because to the application of remote sensing and GIS methods (2011-2022). The survey also revealed that the Wardha city has grown significantly in size. The newly constructed ring-road NH-361 Nagpur-Aurangabad Highway encircling the northern to western limits of the city is the major cause propagating peri-urbanization. This comprises of three villages namely Pipri, Sindi and Sawangi Meghe. The key-factor of development here becomes the rapid thorough transit of the ring road following a linear development of commercial activities. This further invites the housing sector causing conversion of agricultural land-use into residential land use in and around the commercial zones. However, the requirements of physical and social infrastructure are not well developed or planned for the projected population in such peri-urban areas. Need for inclusive and sustainable planning of these zones is very critical to mitigate negative development impact.



Figure 5 Nagpur- Aurangabad NH 361 Ring road

5. Observation and findings:

5.1. Observations

Growing rural-urban interdependencies: Interdependencies are expanding as borders become more hazy. Food, clean water, environmental services, and raw materials are just a few of the commodities and services that urban centres rely on from rural areas, including agriculture and natural resources.

Lack of coordination: There is a tendency for new building to take place in places where there are few laws or insufficient ones, and there is little to no coordination with the government. There is a problem with unlawful land ownership, and the levels of urbanisation in these settlements vary substantially.

Planning & Management: A jurisdictional conflict results from municipal growth. Planning and management are complicated as a result of the involvement of multiple agencies and their lack of coordination in the area.

Core city identity: Whether through migration or because of industrial or housing development projects, the process of population expulsion towards the hinterlands causes difficulties with decadence in the city's centre districts.

Conflict between two policies: On the one hand, there are those who support economic growth in these areas through the relocation of risky enterprises or new land uses. On the other side, we have lax agricultural and environmental preservation rules that make it difficult for productivity and environmental quality to compete with the financial pressures that come from developers driving up land values.

5.2. Findings

Due to land use changes, land grabbing, and environmentally negligent development aimed at growth by unsustainable means, the water supply in periurban areas, which was once secured by multiple water bodies in and around cities, is now in danger. Therefore, in the absence of any formal service provisions, people turn to a variety of informal ways or coping mechanisms to meet their requirements. Because traditional village ponds that were refilled by rainwater are disappearing due to development and other water sources are becoming less accessible, the peri-urban communities that are still engaged in smallholder farming frequently rely on recycled wastewater, which is becoming more and more contaminated. Indian rural-urban changes produce complicated, diversified, and risky conditions for agri-food systems, but they can also open up new opportunities if they are effectively planned.

6. Recommendations and conclusions:

6.1. Recommendations

Due to the importance of urban fringe areas to development, it is necessary to implement effective measures for reducing conflicts, enhancing the rural-urban interface, and gradually integrating urban and periurban areas into the process of urban growth and development. There is a need to design a model to limit and manage settlement growth in peri-urban areas at both the local and regional levels. Urban fringe definitional ambiguity results in subpar policy design, implementation, and policy/program evaluation. Therefore, it is vital to clear up any ambiguity in governance bylaws and agency jurisdiction.

Need for a suitable planning mechanism which would take care of the interactive process between various local bodies, and agencies of state & central government and also to plan and study the pattern of transformation. The planned growth of its periphery areas is essential to the sustainability of the metropolitan city model. Therefore, it is necessary to develop a framework for spatial planning that takes into account the principles of the 1992 Constitution (74th CAA). It is primarily necessary for all agencies' duties in governance and coordination to be completely clear. Social capital and the local initiative's role must be clearly defined and successful.

Control environmental deterioration: As cities grow, they destroy neighbouring green spaces, which has a negative impact on the ecological sustainability of urban and periurban areas. Control urban sprawl – a high rate of urban sprawl is caused by unauthorised and haphazard growth. It is possible to stop these haphazard expansions by studying Peri urban regions.

The supply of basic amenities and efficient transportation links into the city centre must go hand in hand with the construction of cheap housing in suburban areas. In order to overcome the difficulties of sustainable urbanisation, it is important to recognise the peri-urban interface and its marginalised residents as a vital frontier. Agri-food system support should be gradually combined with urban environmental management, health, nutrition, and poverty alleviation measures. Agricultural land use must be fully and efficiently incorporated into planning processes.

6.3. Conclusion

For a better understanding of the dynamics of urbanisation and urban transition, the urban periphery areas of India are among the most active places. Planning and policymaking work hand in hand to improve the quality of life in these places and address issues with the urban infrastructure of upcoming cities. India presents a distinctive condition of population growth and movement from rural to urban areas as well as from one state to another. This indicates that new settlers will be moving into cities for almost the next 50 years.

The constant and crucial concern for Indian planners would be the spatial transition of rural land into urban agglomeration. The effective management and transformation of periurban areas is crucial to the sustainability of both the economy and society. For greater growth, there should be more public participation.

The interface is a challenging area to plan for and administer in a way that will guide actions toward shared goals and objectives across stakeholders in the public, private, and social sectors. The interface is a complicated area with its own issues and plenty of development prospects. It is critical to keep in mind that these areas will, over time, integrate into the cities, and that they will need to adjust to the economic, social, and environmental dynamics of the metropolis to which they will eventually belong.

Due to its thorough understanding of the environment and its research of various interactions within the city-region system, sustainable development has emerged as a useful framework for addressing the rural-urban interface. The execution and oversight of management plans, however, presents a significant difficulty in the context of intricate governmental administrations.

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SOCIO-ECONOMIC ASPECT OF URBANIZATION A CASE OF NASHIK CITY

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Abstract : With a population of roughly 2.18 million in 2022, Nashik is the fourth largest city of Maharashtra. The city is a potential investment city because of its favourable climatic conditions, strong industrial presence, renowned educational institutions, and social and cultural environment. Based on these characteristics, the real estate market in the 25-kilometer radius surrounding Nashik City is booming. The District's GDP has doubled in the last ten years. This has influenced people's purchasing power, and the real-world rise in the vehicle market, real estate, and retail is evidence of this. This research focuses on the farmers of Peri-urban areas and the impact of real estate development on their lives. An attempt has been made in the present study to understand the socio-economic changes in the lives of fringe area landowners. The methodology followed was a questionnaire survey, and interviews of the farmers of Chandshi, Jalalpur, and Mahadeopur which are on the fringes of Gangapur road which is the prime area of real estate. The main aspects studied were to understand the diversification of the income generated through the conversion of their farmland, and willingness to relocate to farther farmlands. It was noted that even though on government records we see agricultural land, the landowners are agriculturists and not native farmers of that village. The farmers view this opportunity of urbanization as a way to change their day-to-day hardships due to a lack of funds. We find a positive and negative impact of the eviction or displacement of the peri-urban farmers in terms of the livelihood that they earn through farming. The chosen few farmers with educated backgrounds were able to diversify their income and benefit from urbanization. Whereas the other population could secure jobs either through their education or proximity of the urban neighbourhood.

Keywords: Socio-Economic Development, Urbanization, Peri-urban land owners.

1. Introduction :

Maharashtra's northern region encompasses the city of Nashik. It is around 190 kilometers north of Mumbai, the state capital. Nashik ranks fourth largest in Maharashtra after, Mumbai, Pune, and Nagpur. Located on the banks of the Godavari River which flows from Trimbakeshwar to vijaywada. Nashik serves as the district's administrative headquarters as well.

Nashik is regarded as "the third most industrialized city in Maharashtra after Mumbai and Pune," mostly because of recent significant industrial growth. National Treasury Printing Press and a significant thermal power plant (Eklahare) are located here. The region around Nashik and its environs is divided into five "Industrial Zones" (Satpur, Ambad, Sinnar, Igatpuri, and Dindori).

There are several sugar mills in the district. White onions and pomegranates of the region are two other top exports from the country. Although Nashik has industrialized, the district's primary industry remains agriculture. Approximately 90% of Indian wine comes from the Nashik Valley. Given that, more than half of India's vineyards and wineries are located here, the city is also known as the "Wine Capital of India" or "India's Napa Valley." Locally renowned wine labels like "Sula" have won recognition on a global scale.

1.1 Population Growth

The population of the city has increased dramatically over the past two decades, going from 1.49 million as of the 2011 Census to nearly 2.18 million in 2022. By 2035, Nashik's population is projected to increase to 3.2 million.¹

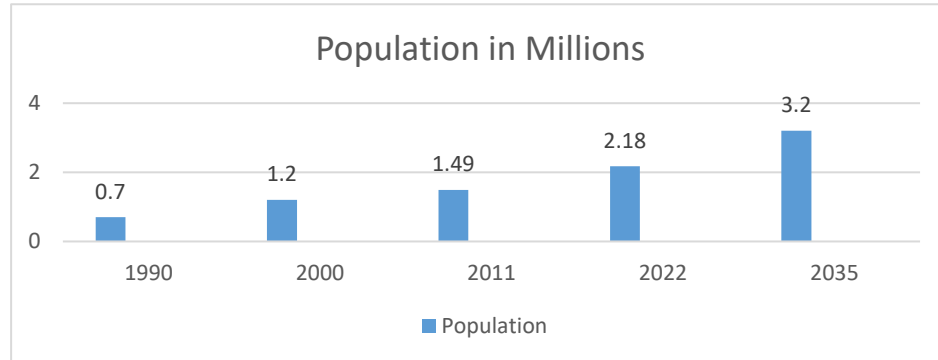


Fig 1 Population Growth of Nashik City (World Census)

1.2 Nashik District Tehsil



Fig 2 Tehsil under Nashik District (Source- Maps of India)

1.3 Nashik City Development

The city has been divided into three sections by the passing of the highways (NH3, NH50). The main development initially took place alongside these highways. The Godavari River's course also split the city in two. Due to its railway and highway connectivity, the city growth was most noticeable along the southern bank of the Godavari River. On the opposite bank of the river, there was agricultural area that was used to grow a variety of crops, including wheat, jawar, bajra, rice, as well as fruits like grapes and vegetables like tomatoes and onions.

Total villages that come under Nashik District - 1960

Small Farm Landowners of the District - 3, 50,956 (54%)

The city's College Road and Gangapur Road neighbourhoods, which have the largest commercial centers, banks, educational institutions, and entertainment facilities, are the most popular and have the highest saleable prices.

In the past, compared to other areas of the city, the Panchavati neighbourhood had not experienced considerable growth in the property sector due to the lack of industries there. New townships are being built on both sides of the 100-foot ring road, which connects Panchavati to the city's busy Gangapur Road in only a few minutes.

3.1 Drivers of the Economy

In recent years, the demand for both residential and commercial space is rising. Established builders, developers like Raheja Group, DLF, DSK Group, Nirman Group, and Bagad Properties are developing projects of apartments, villas, and commercial complexes in the city. This affects the growth of suburbs on the outskirts of the central city.

The announcement of Metro project has made access to markets, employment and, administrative possibilities, medical, and educational services easy. The amount of time spent commuting would be reduced, which would boost population productivity overall.



Fig 4 Metro Route of Nashik (Source-Nashik Metro Project)

3.2 Government Policy

With the new Town planning model, and the Regional plan the developers grasped the peri-urban areas' potential for the growth of the city and purchased sizable agricultural land parcels near the developed land, for instance, in the riverside villages of Chandshi, Jalalpur.



Fig 5 Regional Plan of Nashik District (Source- Regional Plan Nashik)

4 Data of Chandshi, Jalalpur, And Mahadeopur

Table 1 Demographic data

Village	Geographic area in Hec	Net Area in Hec	Total Population	Male	Female	No. of land-owners	Agricultural area	Non-Agricultural
Chandshi	491.15	429.78	2047	1053	994	1317	292.905	136.875 (31.8%)
Jalalpur	1069.09	857.83	2940	1540	1400	1777	857.3	0.53866 (0.06%)
Mahadeopur	334.65	274.02	1708	908	800	321	273.74	0.28 (0.10%)

4.1 Connectivity to Gangapur RoadC



Fig 6 Connectivity from Anandwalli Gangapur Road (Source Nashik City Map)

4.2 Chandshi

Chandshi farmers cultivate wheat as kharip crop along with tomatoes, green leafy vegetables, coriander. Alongside these there are rose, guava, and grape farms.

The Regional Plan proposed the Chandshi village in Yellow zone. Due to its connectivity to Gangapur road (which is just 2.7 kilometres) on one side and Mhasrul-Makhamalabad road on the other side, farmland was converted to non-agricultural land at a faster rate than Jalapur or Mahadeopur. This further initiated the developers and agriculturists (People whose previous generations were farmers) to start buying land in this village. Though data does not show a change in land uses the native farmers of the village are replaced by agriculturists. The outsiders in the village are approximately 80-85%.

The developers started building apartments or developing layouts of bungalow plots and selling at a lesser rate than the city. The urban dweller who could not buy a dwelling unit in the urban area opted to buy bigger units here. Due to the SmartCity project, the development happens in these areas under the guidelines of NMRDA. The MSRTC connectivity and seater rickshaw made it possible for the children of the village to approach the schools, colleges in the city easy. The younger generation was lured to work in malls, and started considering working in farm below dignity. The girls of the village could get easy access to education which changed the psychology of the family. The developed residential layouts provided opportunities for the villagers of Jalapur, Mahadeopur to work as drivers, house help, gardener, etc.

The rates of farmland in Chandsi are high as compared to Jalapur and Mahadeopur. As per RR, 1.5 times to Jalapur.

4.3 Jalapur

Compared to Chandshi Jalapur is 4.2 kilometres from Gangapur road. Major crops of this village are Wheat, soybean, cabbage, cauliflower, green leafy vegetables, and capsicum. Many of the farmers have irrigation systems installed; few have wells in their farms. Farmers with accessibility to river water lift the water or farms adjacent to the canal have benefits of farming throughout the year.

Jalapur also comes under yellow zone in the Regional Plan. As per the data received at present one third of the farmers are agriculturists. The percentage of outsiders is approximately 30-35%. The conversion of non-agriculture land use is limited or negligible 0.06%.

The connectivity by MSRTC bus and seat rickshaws made it easy for the younger generation to get jobs in the urban areas like house help maids, drivers, etc. Most of the land is under contract with the developers or bought by the agriculturist. As per RR, 10% more than Mahadeopur.

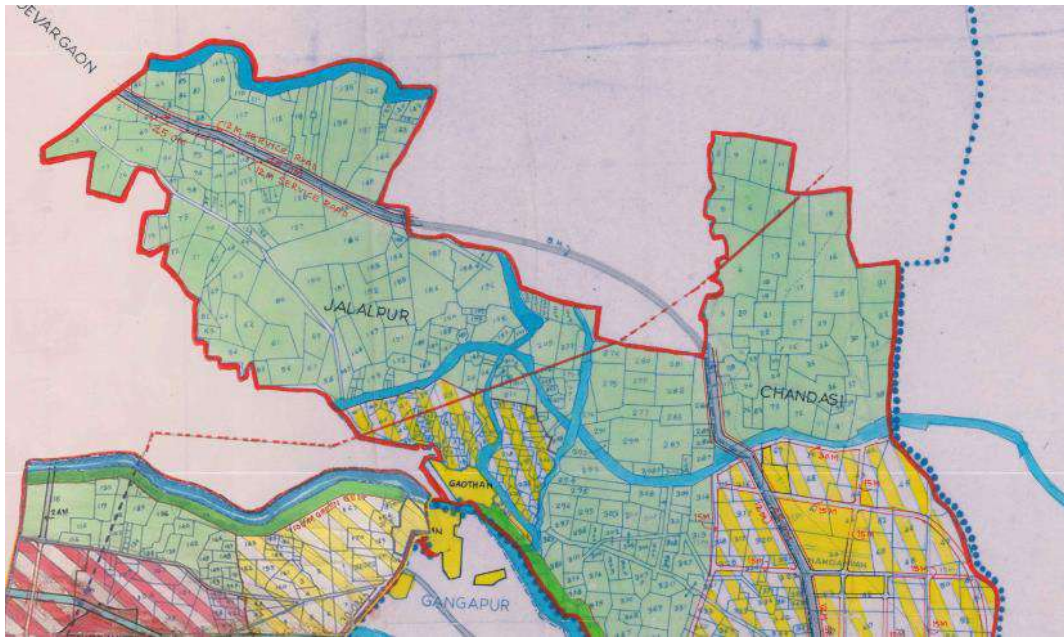


Fig 7 Regional Plan showing Chandshi, Jalalpur, Mahadeopur (Source Regional Plan Nashik)

4.4 Mahadeopur

Compared to Chandshi, and Jalalpur Mahadeopur is farther from Gangapur road (9.6 kilometres) and that is the reason that urbanization has not affected this area at present. The main crops taken in this area are vegetables like tomatoes, bottle gourd, ridge gourd, sponge gourd, green leafy vegetables, coriander, and Capsicum. There are a few grape vineyards in this village.

The Regional plan does not show Mahadeopur under yellow zone yet. This is the reason the farms in the radius of 500m from the urban boundary only could be benefitted. The outsiders are approximately 10-15%. Though the developers have done initial investments with farmland owners, the farmers of this village continue to do their farming activity.

5. Observations

The farmers owning up to 2-acre land on their names used to earn with kharip crop of wheat and other crops like tomatoes and vegetables around 1.5 lakh per acre annually. However, with the uncertainty of rainfall and other weather conditions and hardships involved, it is not the same every year. A few examples of demographic and socioeconomic factors are age, education, farmland, family size, and access to infrastructure. These were the primary determinants of these farmers' future

The farmers in Chandshi and Jalalpur recognized the potential of their farmland in light of urbanization trends. Either on their own or in partnership with other developers, they began converting their

farmlands to create layouts. Following this development, the farmers' financial situation changed due to the good prices they obtained.

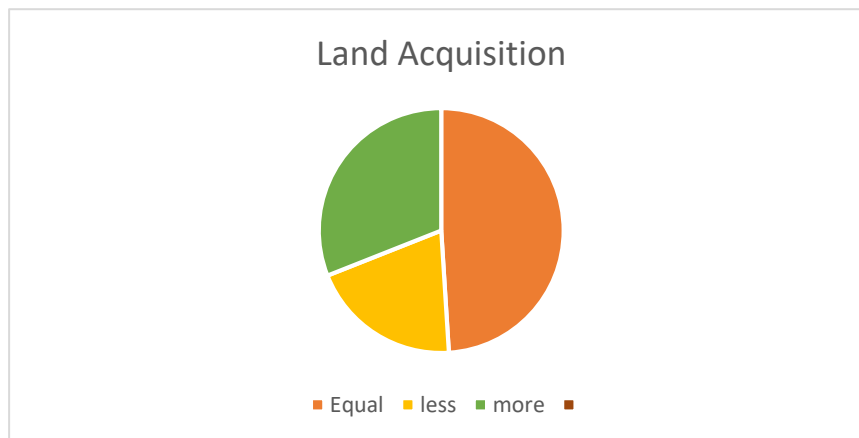


Fig 8 Farmers acquisition of New land (Source- This study)

It was observed that when the farm was divided into more siblings each got a smaller piece of their ancestral land. Thus there was seen a trend to convert the land at these prime locations and move away to the periphery of the district where they could claim a bigger piece of land on their name. Most of the farmers in these areas who have converted their property have purchased larger farmlands 35 to 50 Kilometres away from these villages. Along with investing in bigger farms, they also invested in cars, and home improvements. One of the respondents informed that they had a native land of 8-acre and four siblings after converting the land they could purchase approximately 50 acres of land in Rasegao village on Vani road. This is evidence of the positive impact of urbanization.

More than half of the farmland owners were able to acquire the same amount of land about 21% less since they had more title owners (number of siblings), but they were still able to improve their homes and buy themselves cars. The educated farmers were able to diversify and supplement their income by operating small businesses like transportation, fabrication, dairy, and venturing into construction to earn rent.

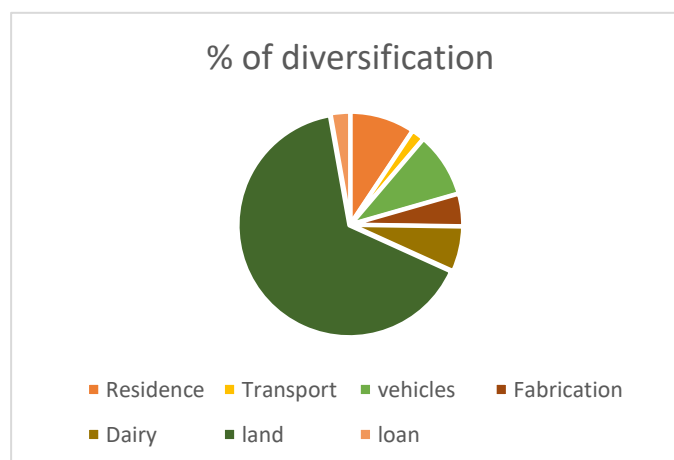


Fig 9 Percentage Diversification of Income (Source- This study)

The less fortunate ones had to repay the loans secured for bore wells' marriages, education, hospitalization etc. and had to move further away for survival. They have bitter sweet feelings about urbanization. The small and less educated farmers are the ones who always face issues to earn a humble living. It is observed that against an expense of Rs.1,00,000/- for an acre for the crop of tomato the farmer might earn up to Rs.3,00,000/- in a year and another year he might not even get Rs.50,000/-. These kind of uncertainties compels the farmer to consider selling his land for a price that he might earn in his full lifetime.

The Adivasi farmers rely mostly on rainfall for their crops and then rest of the year they work on other farmers lands to earn a living. After selling their farmland, they have earned employment on construction sites. This has given them a surety of income.

6. Conclusion

The economic characteristics of the peri-urban interface are impacted by changes in land use from rural to urban activity. An open countryside with peri-urban areas primarily populated by agricultural villages defines the urban perimeter, from which urban settlement spreads. Urban growth typically occurs by intruding on productive agricultural land. The farmers in this peri-urban area are consequently evicted.

The majority of rural residents rely on agriculture for their living. The community in peri-urban areas adopts a variety of livelihood choices to meet their needs depending on how rural and urban the place is. The small and Adivasi farmers work on other farms or as labour on construction site to complete their daily needs. According to the impact assessment estimation, peri-urban farmers' socioeconomic condition is significantly impacted by urban growth. It was observed that due to urbanization, the psychology of the farmers of particularly these 3 villages has changed considerably. The literacy rate has increased which has changed the habits of the rural dweller.

It has been noted that prime agricultural property is purchased for the development of residential communities, commercial structures, and educational facilities. Opportunity, affordability, and location of the farmland all play a significant role in the decision to sell the farms for conversion to urban use or amenity. This puts pressure on the peri-urban farmer to move to another location where they may continue to rely on farming for their living. Some farmers could grow economically by moving away from these villages and further away from the city. Many smaller farmers with less than or up to 2 acre of land have moved to Rasegaon, Umrle and Pimpalnere. Farmers' economic decisions are influenced by their social environment in addition to market conditions. They frequently view these chances as ways to improve their financial situation and leave farming behind (the younger generation). Currently almost all farmers younger generation is educated few with higher education. The educated younger generation does not intend to work in the farm by themselves and needs labour, which are now difficult to find. Many of them do not wish to live in a rural background and wish to be part of an urban community.

The study's main motivation was to comprehend how the farmers in these regions think and how they view numerous advantages and disadvantages of urbanization. Farmers, do not benefit from the urban setup in place of their lands, because majority of them are relocated from their traditional homeland to far periphery areas. The decision to leave their ancestral property behind and move to a new farm is difficult for the farmers. When they leave, a different sociological setup of households will occupy that space. Due to their rural upbringing, farmers are aware that it would be challenging for them to lead a lifestyle comparable to urban dwellers.

We could conclude that urbanization has a positive as well as negative and considerable impact on the peri-urban farmers' economic well-being and social psychology. Due to urbanization, a lesser number

of farmers continue to do farming. The younger generation has got jobs in all other sectors. At the same time, we could also conclude that the farmers who did not have land but had the money against it could survive the pandemic in a better way. Planners need to deliberate on the displacement of farmers and farmland by considering setting up new satellite towns instead of expanding the boundary of the city into the green zone.

Acknowledgements

I take this opportunity to thank Ar. Sulakshana Mahajan madam for all the valueable time spent to discuss with me and give direction to this research work. I would also like to thank the Talathi Mr. Sanjay Kapadnis for sparing valuable time and sharing all the official data with me. Further this reaesrch would not have been possible without the help of Mr. Jagdish Gulave resident of Chandshi village and my friend Ar. Ashish Patil who is an agriculturist and investor in these villages.

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Regional Plan of Nashik

Development plan of Nashik

TO UNDERSTAND THE LIFESTYLE AND ASPIRATIONS OF PERI URBAN DWELLERS VIA THE COMPARATIVE STUDY OF THREE PERI-URBAN VILLAGES IN INDIA, THROUGH ITS' ARCHITECTURAL DOCUMENTATION AND STUDY.

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Abstract: The three villages, Jana located at 34 km from the town of Kullu, Dhawad located at 21 km from the town of Khajuraho and Thakurwadi located at 14 km from Panvel are all peri urban villages that were undertaken for the purpose of architectural documentation and study in 2016, 2017 and 2018 respectively at the IES college of Architecture. Batches of 60 students each, guided by 6 faculty members, measure drew part (in Jana) or entire settlements (Dhawad and Thakurwadi). Along with these measure drawings, intangible data was collected through interactions, interviews, and observations.

For this paper, the data hence gathered is used along with other secondary sources a comparative study is undertaken to study the architectural and socio-cultural characteristics. Through this an attempt is made to learn about the modern-day aspirations of the peri urban dwellers in the country.

KEY WORDS: COMPARATIVE STUDY; ASPIRATION; ARCHITECTURAL DOCUMENTATION; LIFESTYLE; SETTLEMENT STUDY

1. Introduction :

1.1Background

As architects we are professionals who can literally and physically make or break a family, a community sometimes even countries. Using our design processes and concepts we have been categorically and subtly dictating over people into telling them how they should be living, within and outside of their homes. Almost making them believe that the solution we are giving them is the most appropriate. Through my clients, students, and people around me I have been in a pursuit to find out if we really do this job well. Do we really give them solutions that tick marks all the check boxes of a client brief?

Besides dealing with the urban apartment designs and interiors, one demographic category that has been intriguing is the rural population. My interactions with this category have been very brief. It has been via the study and documentation trips conducted via IES College of Architecture, where we spent 4-5 days in the villages, measured and plotted the houses, roads, nodes, vegetation. In the process we spent 7-8 hours a day keenly observing the peoples' lives. Walking within their homes, kitchens, toilets,

villages, and boundaries- sometimes even stepping over these unknowingly. These interactions have been enriching, fascinating and sometimes eye opening. Having documented three peri urban villages of Jana, Dhawad and Thakurwadi drawing a comparison amongst the three has thus been a curious journey. Since the villages are in three different climatic zones of the country, the comparisons brought out some surprising and some obvious findings, thus making the research an exciting experience.

1.2 Aim:

To understand the lifestyle and aspirations of peri-urban dwellers via the comparative study of three peri-urban villages in India, through its architectural documentation and study.

1.3 Objective

To observe and understand the lifestyle of the peri urban dwellers of the three villages.
To study and compare the architectural character of the three villages.
To study and compare the socio-cultural aspects of the village.
To understand the aspirations of the peri urban dwellers via the comparative study.

1.4 Limitations

The observational and qualitative studies are done over a span of 5 days only. The aim and objective are of qualitative in nature these may or may not be measurable empirically. In Dhawad we were fortunate to witness the Navratri festival (on the 8th day late evening of the Navratri) and thus had witnessed a piece of the culture up close. The same is not the case with other villages. In Jana we documented 6-7 houses scattered in the lower parts of the village as permission to do so was not available. While Dhawad and Thakurwadi are completely measure drawn. The architectural data that features in the paper is collected by the students, is academically oriented and thus may be inaccurate as the tools and techniques used are amateur. The opinions and aspirations of the people are documented using conversations and observations.

1.5 Methodology

The methodology undertaken is qualitative and observational. Inspired by the study of Ekistics¹, the data is categorised under four main headers of Man and Society, Man and Nature, Man and Network and Man and enclosures². Under the header of Man and Society, all the generic and overall aspects of the villages are studied like overall accessibility, facilities, culture, and opinions. Under the category of Man and nature, the aspects that relate to nature are covered. Man and network covers aspects of connectivity like roads, service networks like electricity, water and sewage and digital connections. The methodology culminates with Man and Enclosure that is study and comparison using the architectural aspects. Documented drawings are also compared.

¹ Ekistics is the science of human settlements including regional, city, community planning and dwelling design. The study involves every kind of human settlement, with particular attention to geography, ecology, human psychology, anthropology, culture, politics, and occasionally aesthetics. - https://en.wikipedia.org/wiki/Ekistics#cite_note-ReferenceA-1

² Ekistics involves the descriptive study of all kinds of human settlements and the formulation of general conclusions aimed at achieving harmony between the inhabitants of a settlement and their physical and sociocultural environments. Descriptive study involves the examination of the content, such as man alone or in societies, of a settlement, and the settlement container, or the physical settlement, composed of natural and human-made elements. <https://www.britannica.com/topic/ekistics>

Jana

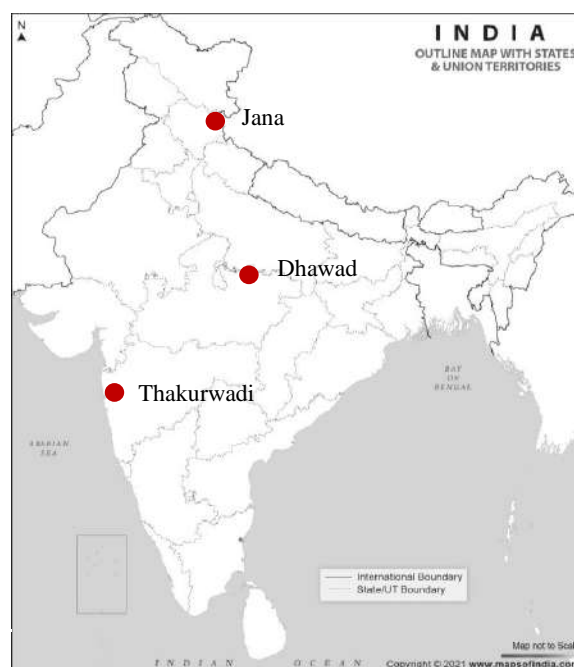
Located approximately 12km from Naggar is a small settlement along the sun facing southern façade of the hill. The southern side receives maximum heat that helps in the harsh snow cladded winter of the village. The access to the village is via pucca road and the settlement is entered from the top. The top parts have large homes in kathkoni style of vernacular architecture, belonging to the Thakurs and upper caste. As one descends, the houses are a smaller and denser with composite systems of constructions. The village has 3-4 temples- all belonging to their local demi gods and deities and all built in kath-koni, none allowing access to any outsiders. The biggest temple did not permit even the local lower caste families.

Dhawad

Dhawad or Dhabad is located at 16km from Khajuraho town. It is located along the Khaddar river, so to reach the village one has to cross a bridge. A radial organic pattern is observed in the settlement with the outcastes/ harijans located as a separate cluster with a separate entrance and own shrine. Along the main spines reside the *Thakurs*, *Pathaks* and *Joshis*- the higher caste. A separate cluster for *Chammars* (leather workers, lower caste but above *harijans*) *Guptas*, *Vishwakarmas*- relatively higher caste. The higher castes have traditional mud plastered white washed homes with flat roofs. Temples were not very eye catching but held important position in psyche of people. Gram panchayat was important but located a kilometre away from main settlement. The post office of the village was a feature of pride.

Thakurwadi (Haltep)

Located at 14km from Panvel (suburb of Mumbai) the village is the last eastern settlement before the western ghats of Panvel (lies at the base of Prabalgad). It is a settlement that appears to be rural from afar but appears awkward as a settlement. Traditionally being *adivasis*, the village is probably a new village and villagers seemed to be given housing by an authoritative body. Being closest to a metro the village also has a flavour of peri-urban.



1.5.1 Man and Society

Table 1: The table below compares the various aspects of Man and society.

Man and Society			
	Jana	Dhawad	Thakurwadi
State	Himachal Pradesh	Madhya Pradesh	Maharashtra
Nearest town	Naggar (12 km)	Khajuraho (21 km)	Panvel (14 km)
Gram panchayat	Yes	Yes	Shared
No. of houses	80-100	30-40	20-30
No. of schools	1	1	1
Planning Principle	Hierarchical	Radial/Organic	Linear/Organic
First Aid facility/ accessibility	Naggar (12 km)	Clinic but no doctor, thus Khajuraho (21km)	Belavali (7 km) Moving medical van once in two weeks
Vehicles owned	Rare	1- 2 wheeler/ family	1- 2 wheeler/family
No. of Shops	2 to 3	2 to 3	1
No. of temples	3 to 4	3 to 4	1
Shrine	Demi gods, village deities	Demi gods, village deities- potted plants for Navratri	Hanuman
Festivals	Spring mela	Navratri, Diwali, Holi	Hanuman Jayanti
Dressing	Few women in traditional attire	Urban dressing	Urban dressing
Caste sensitive	Yes, Higher the contour, higher the caste	Yes, Separate cluster for Harijans.	None
Opinion on RCC construction	R.C.C is Very bad for cold temperature and for earthquake.	Best system as not required to replaster mud walls.	Live in R.C.C homes. But overall are satisfied.
Aspiration of the villagers	Standing kitchen Personal toilet.	Want Separate schools for upper caste	Need Employment opportunities

1.5.2 Man and Nature

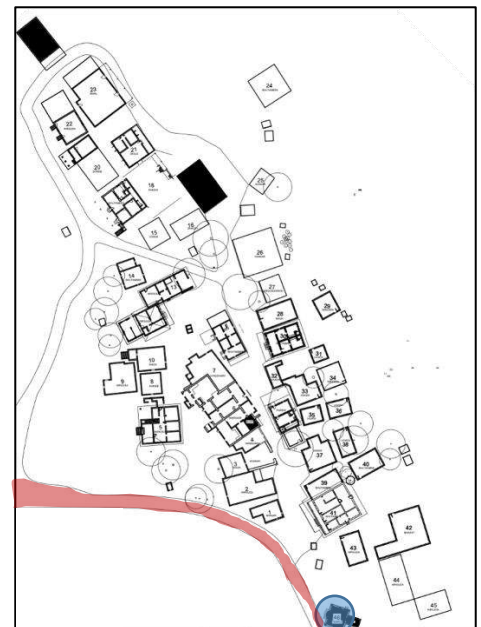
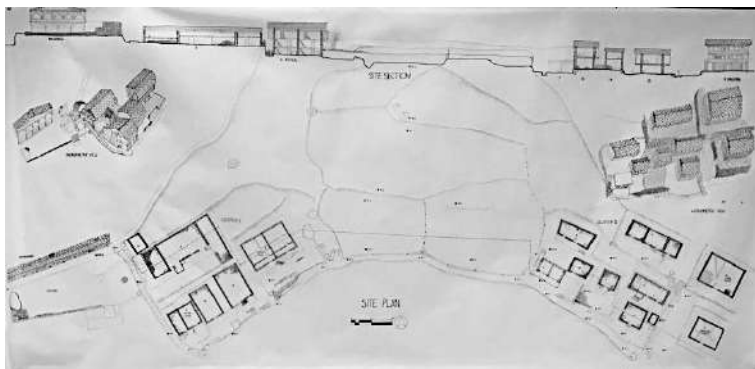
Table 2 : The table below compares the various aspects of Man and nature.

Man and Nature			
	Jana	Dhawad	Thakurwadi
Land type	Mountainous	Flat land bank of river	Flat to mild contours,
Climatic zone	Cold	Composite	Hot and humid
River/waterbody	Beas	Khaddar	Well

Vegetation	Tall Deodhar trees	Sparse	Sparse
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From the two tables above, it is observed that the villages that are closer to larger cities of course have better access to facilities and metros but they are also more prone to an open minded set of values. Jana had a few houses in R.C.C. But the villagers were not keen on building in R.C.C as it did not resist the freezing temperatures of winter and were not seismic-proof as compared to their traditional *kath-koni* homes. Even though their families expanded and demanded spaces, and in spite of the government of Himachal Pradesh banned the cutting of trees for building homes, the villagers valued their timber and stone dwellings. On other hand Dhawad had mud and wattle and daub construction- sustainable, eco-friendly but demanded heavy maintenance. The women of all households had to plaster the walls of the homes every 6-9 months. And thus their inclination towards R.C.C homes was inevitable. The villages that are away from the larger cities have better value systems for the traditions.

In contrast to this, the villages away from larger cities have a much more constrictive world view- Jana was heavily rooted in its Thakurs and *jatis*. Once stepped in the home of a lower caste (even for purpose of documentation) we were not allowed in the upper caste homes. Dhawad has a separate cluster for the *harijans* and *adivasis*. The character of this part of the village was completely different- with short entrances to the homes, thatched roofs, shared toilets with poor design and in ruins, located adjacent to the village dumpster. The people of other clusters even refused to send their children to play or study with the children of the harijans. The Thakurwadi settlement had no such reservations.



1.5.3 Man and Networks

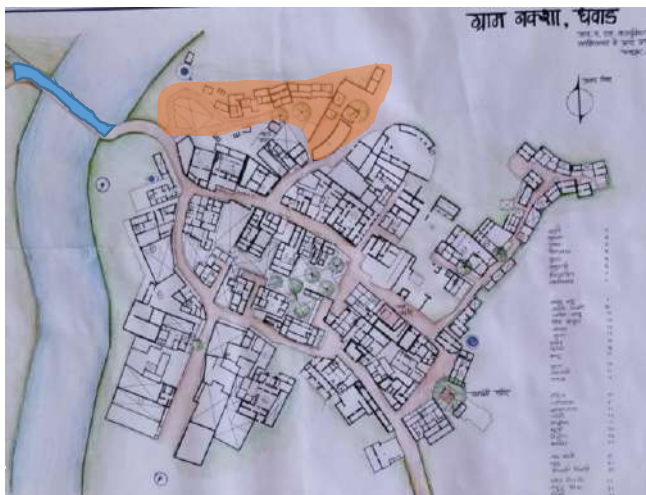


Table 3 : The table below compares the various interpretations of Man and networks.

Man and Network

	Jana	Dhawad	Thakurwadi
Vehicular access	Kuchha internal roads Pucca main access	Kuchha internal roads Pucca main access	Pucca internal roads
Digital Network	Bleak	Excellent	Excellent
Social network	Node at temple	Node at tree +temple	Node at temple school
Sewage system	Exposed-along streets	Exposed-along streets	Covered-underground
Water Supply	None. Shared tap	Yes	Well filled by tanker
Electricity	Yes, exposed, with load shedding	Yes, exposed, with load shedding	Yes, exposed, with load shedding

The table clearly indicates that as one nears larger metros and cities, the availability and quality of services is superior in nature. Amongst the three villages, Thakurwadi is best connected internally and with the world outside. Poor quality of sanitation but great digital and phone connectivity is common across the villages. Social interaction and pause points are inseparable from the religious points of all the settlements.



Figure 6: The exposed electricity wires visible through the internal kuchha roads of Dhawad. Mud plastered walls of the houses are also visible.
Source: Author



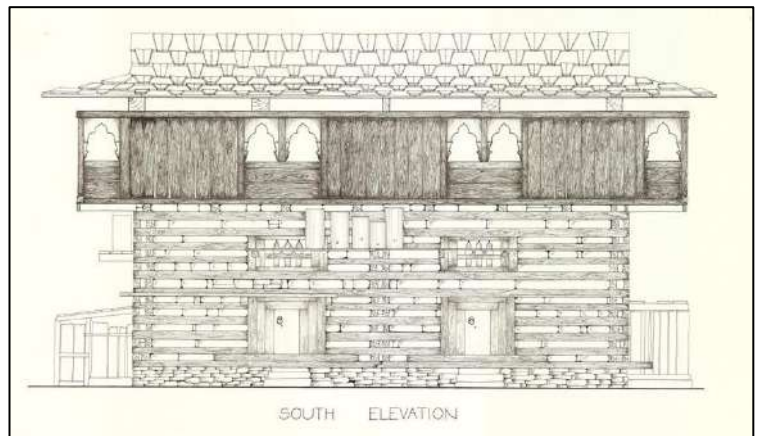
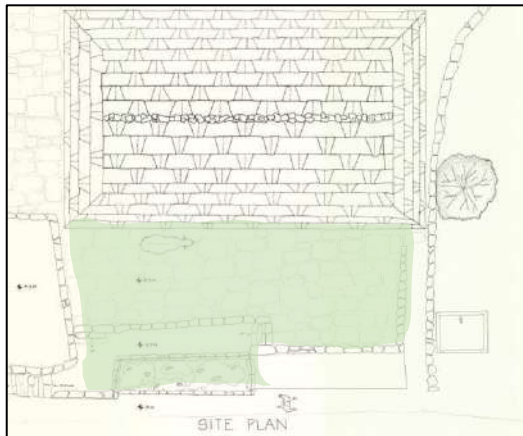
1.5.4 Man and Shell

The stark difference in the climate of the three settlements helps in understanding the relationship of humans with their built environment. They have a strong response to its immediate environment in form of the materials used, the roofing systems, fenestration details, materials and planning principles and

internal space syntax. What is extremely interesting that though the three have different proportions, locations of the ‘yard’, each has similar functions.

Table 4: The table below compares the various relationships of Man and shells/built environment.

Man and Shell			
	Jana	Dhawad	Thakurwadi
Appearance	Kath-koni-grey brown with slate tiled roofs	mud- White washed	brick red, exposed bricks/ un plastered
Roof	Sloping, Slate tiles	Gentle slope, Clay tiles	sloping, tin clay tiles
Construction typology	Kath koni, RCC, 3 storey	Rammed earth+brick mud plastered, load bearing, RCC, 1-2 storey	Load bearing + wattle and daub, RCC, 1-2 storey
Ground floor	Cattle pen	Living spaces, kitchen central courtyard	Living rooms kitchen. Detached toilet
1st Floor	Living areas	Rooms/terrace	Rooms
2nd floor/Attic	Kitchen	none	none
Yard typology	Front yard	Courtyard	Front and backyard
Yard Uses	Animal rearing, socialising, growing vegetables, grain drying, washing		
Staircase	Timber	Timber	Metal/RCC
Door	Timber short in height	Regular height (2.1m)	Regular height (2.1m)
Window	small	none	big windows
Aangan/porch	yes	yes	yes
Toilet	Shared.1 for 10	In courtyard.	Outside the house.



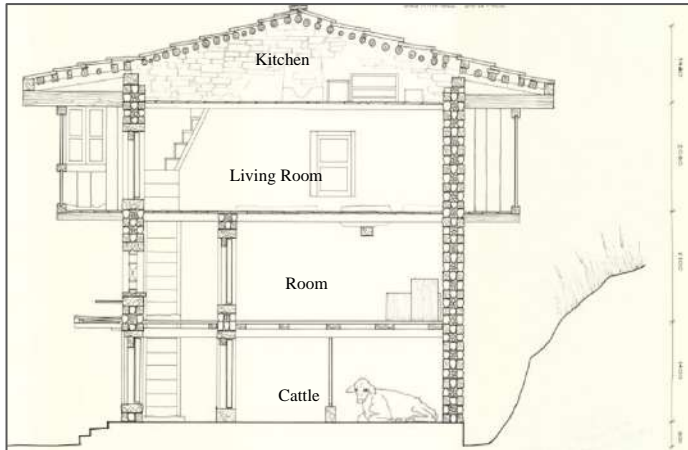


Figure 11: A kathkoni section of Ramlal's house at Jana. The kitchen is located in the attic of the house. Source: IESCOA semester 4 2017-18



Figure 13 and 14: The various activities of the yard at Thakurwadi. The outdoor toilet is also visible in the background in figure 13 and clothes drying and parking in figure 14.

Source: IESCOA Semester 4 2019-20

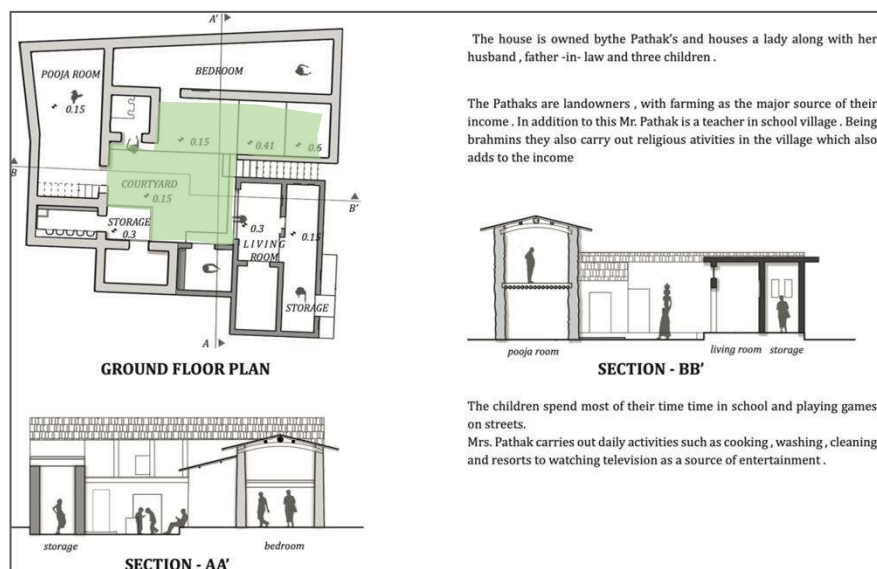


Figure 15: A page from the report on Dhawad as compiled by IESCOA semester 4 2018-19. Note the courtyard in the centre of the house, the gently sloped roof and a composite construction.

The villages are beautiful. The experience of documenting and measure drawing these have been enriching to students and faculty both. All village trips were undertaken with official permissions from the sarpanch and authorities involved. The people were extremely co-operative, friendly and comforting. We have used empty built and unbuilt spaces like gram panchayat office, the sarpanch's home at Dhawad, the temple node at Jana and the temple complex of Thakurwadi for discussions and meals. The villages did not have any base drawings. We made sure we left behind no urban waste like plastic water bottles, packets etc.

One of the best things experienced, was, the villagers never touched our belongings be it laptops, backpacks, mobile phones, pens, pencils etc.

However, there were some uncomfortable instances; of two-house owners in Jana asking for 6000 rupees each if we wished to continue documenting their homes. We met some sadhus in Orchha, who asked for a fee to be clicked. We were enquired about our castes at the door step of an upper caste in Dhawad; and requested by the home owners of Jana to not disclose our involvement in their dwellings to the upper caste villagers. Even before we began our documentation at Dhawad, we were enquired about our respective castes.

Though the houses are documented, we noticed some common social constraints. The homes in Jana and Dhawad had large families that were in conflict; thus, seeing partitions within a single unit was very common. We also noticed several abandoned houses in Dhawad- people living in metros for better opportunities (Figure 2).

As per the aspirations of villagers, a good and accessible education and health system, employment opportunities, basic hygienic sanitation facilities, less burden on women, no gender and caste discrimination are the recurring themes across the villages.

We as designers probably need to document, survey and enquire before we get to design- be it homes, policies or regional plans. We need to design more sustainable, hybrid systems and materials that also optimally use human effort and not burden. The aspirations of an urban designer and that of a rural dweller may not intersect at all if these decisions are taken in an urban, air-conditioned office. Lastly, to begin with, we need to value what we are made of- villages.

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BRIDGING THE GAP BETWEEN ARCHITECTURE AND COMMON MAN

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Abstract : The capacity to comprehend our environment through the light that enters our eyes is known as visual perception. Understanding depth, distance, and relationships to the objects around us is known as space perception. Humans are capable of perceiving, accepting, learning, and acting in accordance with movement. They are also capable of acting in accordance with suggestions made by information and signs systems. Human perception of space and of information systems in space must be considered while designing a place. People are given guidelines on how to act by information and visuals. This research aims to examine how the common man perceives architecture, particularly when it comes to facade treatments and design, moving on to the study of movement representation. The analysis of this research is based on Pune's architecture and cityscape. The well-known Wada and ancient architecture of Pune was thoroughly compared to latest advancements in architecture. A photographic survey based on the typologies of residential and commercial structures was carried out as part of the research methodology. Based on their preferences for the material, respondents were asked to rank which construction material would work best for the corresponding typologies. This research, which collected comments based on respondents' visits to Pune, had a target sample size of 60 people. Thus, a person's visual perception of architecture is influenced by several factors, including materials, interior design, lighting, façade treatments, and more. This study's methodology has been focused on examining how materials affect people, which further shapes how they see architecture. It later discusses the powerfulness that architecture needs to sustain as it provides humans with visual comfort and appeal. The paper will be concluded with exploring the smaller scale of the (narrowed down typology) architectural approach in relation to connection with space.

Keywords: Façade, Common Man, Humans, Perception, Emotions, Perspective, Spaces in architecture, Movement.

1. Introduction :

Winston Churchill once said, "We shape our structures, and then our buildings shape us," as he thought whilst repairing the bomb-damaged House of Commons in 1943. All that is left to be asked is, "What is architecture?" What is the first thing you think of when you see a building? Understanding the value and function of humans in architecture is the goal of this study. Most of the time, architects struggle to convey to the client verbally and linguistically what they have in mind for a particular project. To construct the type of structure an architect desires, it is crucial to comprehend and ascertain the process of thoughts and opinions a common man goes through after viewing numerous architectural aspects.

2. Literature review:

Aesthetic appeal of a building, in architecture, has a key concern and is generally adjudged a subjective feature. Yet some buildings are appreciated worldwide, while some others are criticized. Possibilities are there that certain built form characteristics exist, which make buildings appeal to the

mass. This study attempts to realize those intentionally or intuitively used parameters for the aesthetic appraisal of a building's external form (Jennatha & Nidhish, 2015). In order to determine what makes different buildings visually pleasing and how an exterior shape influences the evaluation of internal space quality, a variety of structures were investigated, and their form aspects were analysed. A survey was undertaken among a target user population, in this case college students, to assess the aesthetic appeal of certain public buildings, in this case library buildings, and to gauge how well they meet the desired functional and quality standards. The data gained demonstrates that there are built-form characteristics that the current community prefers, and that there is a strong positive association between predicted utility and architectural aesthetic appeal. Some people thrive on change at the very same time others will do all they can to resist it. Is advocating these changes as a good thing, always, right? It is not just the change that is beneficial for us; it is our capability to convert this change into an opportunity that makes us understand things in a better way. Change is the backbone of progression, evolution but at times some loopholes find their way which must be properly addressed or could turn into a perilous scenario. In a nutshell same is the case of evolution in field of architecture in past few decades and its understanding by the society must go hand in hand (Das & November 2017). Dating back to any age till renaissance the difference was not as vast as it is in the contemporary times. And this difference started to set its root in industrial age. Sensitivity of architects towards architecture was always the same but thoughts of other parts of society by dint seemed to have same sensitivity towards the edifices. 'Less is more'-by Mies was reframed as 'less is bore' by Robert Venturi.

3. Material and method

3.1 History of Pune

The analysis of this research is based on Pune's architecture and cityscape. P The well-known Wada and ancient architecture of Pune was thoroughly compared to latest advancements in architecture. This research, which collected comments based on respondents' visits to Pune, had a target sample size of 60 people.

3.2 Architecture and The Common Man

What is Architecture? Or rather what it isn't? It is a pitiful truth that only a handful can understand. Few people understand it, and many others go through life assuming they do. A building isn't merely just a roof with walls providing shelter. It is an expression of the mind map of how spaces interlock, to form major spaces fulfilling functional needs and how the spaces resonate with the surrounding nature; how the space as a whole is climatologically able and healthy. To achieve this, we as architects and architecture students must be clear to know the different communication styles with another fellow architect/architecture student/client/layman (workers on site), etc. Let us look at the problems that we as architects/students of today face while conversing with the public in day-to-day life, shall we? How would you feel if the doctor diagnosed you with the statement? "You Have rhinovirus infection of the upper respiratory system, including the nose, throat, sinuses, Eustachian tubes, trachea, larynx, and bronchial tubes"? We would blink in confusion! A much better statement would be "It is common cold". Wouldn't that make many things easier for the patient? A client is just the same. He/she wouldn't probably understand Corinthian order until you show them a picture of it. Or any style of order for that matter - be it Greek, ionic or Doric. It is true that architects can use terms and phrases complicated to the layman or anyone outside the field of Architecture (Devi Priya Manivannan, 2020). It is crucial for an architect to successfully convey to the client what they have imagined in words and conversation. Only that will assist in project completion and adequately honor it. Otherwise, what you perceive as a finished object in front of you is really the outcome of disagreements over building construction.

3.2 Research Method

3.2.1 Flow chart:

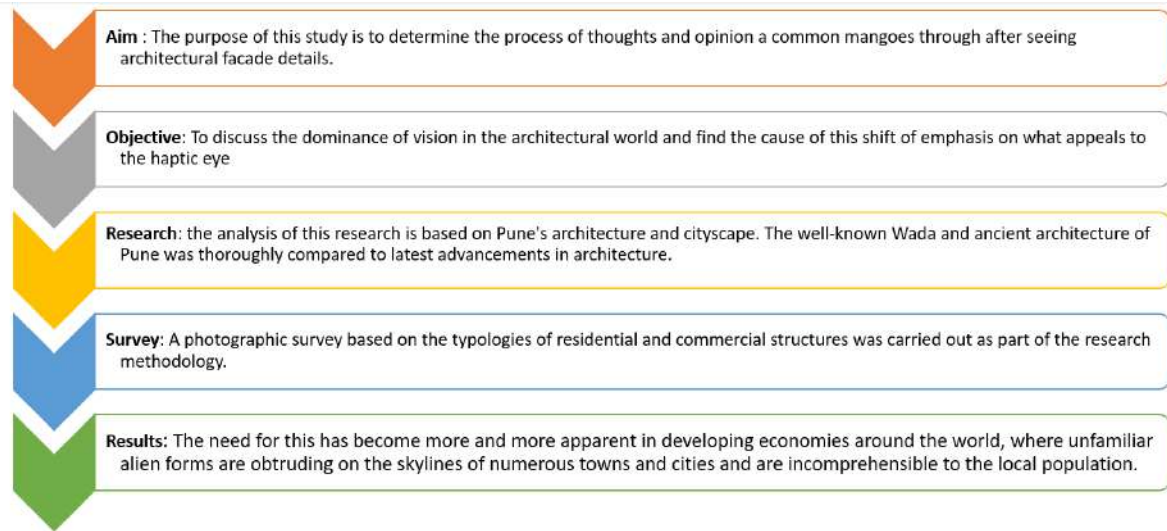


Fig. 01 Flow Chart explaining the process of the research

3.3 Perception

Is perception necessary for existence in the world? The world is where we are because of perception. Our ability to perceive reality, learn about it, and interact with the environment are all aspects of perception. Architecture is experienced through perception, which is founded on the spatial orientation, identification, and representation that collectively enable our sense of place. Architecture involves both sight and feeling. In architecture, space can be discussed in a variety of ways. For instance, we can talk about architectural space, which includes both inside and outside space; urban space, which includes the physical structure of the entire built environment; or existential space, which includes the interaction between a person and his physical surroundings. The experience of place, the sense of place, and its beginnings are of utmost importance in this research because they represent man's most profound understanding of his surroundings and represent the most singular experience of space.

3.4 Visual Perception

A key issue in architecture is human visual perception. This is so because spatial experience and cognition, which are important aspects of design, rely heavily on information gained through visual perception. The creation of a visual perception model is important for architectural design because it can raise awareness of the perceptual effects of design choices. There are numerous ways to classify visual perception, some of which were taken into account when the survey was being conducted. The following were the parameters that were observed:

Sr.No	Parameters	
01	Color	Colors and their perceptions are responsible for a series of conscious and subconscious stimuli in our psycho-spatial relationship. Color can show a certain volume or constructive detail, or visually mimic certain aspects of space. It can also provide a set of emotions or visual effects (Matheus Pereira, June 2018).
02	Form and Shape	“Shape” is not strictly and directly only a set of physical properties derived from objects in the world but is foremost a

		proposal of the mind, a presentation, which is correlated with the physical cues available to our senses. Hence shape cannot simply be derived from affordances of object out in the world but can rather only be understood via the interface (here visual) that our mind controls (Leymarie, October 2011).
03	Materials and Texture	In architecture, texture serves two purposes: it conveys information about the quality of the materials used as well as provides light a specific quality. Understanding the influence of texture as well as the fundamental visual mechanisms that respond to all visual stimuli, including texture, are both facilitated by texture perception.
04	Aesthetics	In architecture, a building's aesthetic appeal is a huge concern and is typically regarded as a subjective feature. While certain structures receive praise from people across the world, others receive criticism. (Jennatha & Nidhish, 2015). There is a strong positive association between a building's visual appeal and its anticipated functionality.
05	Interiors	When communicating design concepts to clients and developing designs, interior designers must be proficient in visual communication methods and strategies.
06	Heights and Volume	Boundary height and space perception of the physical environment both have a great impact. It seems that people preferred ceilings that are higher than average, and that preference for ceiling height changed depending on what the occupants were doing in the space.
07	Value	Architecture is an expression of values – the way we build reflects the way we live. Sometimes we must explore the past to find inspiration for the future. At its most noble, architecture is the embodiment of our civic values. (Tholl, 2014).
08	Nature	Man is surrounded by nature, which is harmonious and unique in all respects. For this reason, there has always been and is a need to see some of this nature in the architecture of the house and other buildings. In architectural design, natural components are actively involved in enhancing aesthetic harmony (S V Ilvitskaya, November 2020).

Table. 01, A concise summary of the parameters of Visual Perception

Because, human vision involves both the eye and the brain, modelling it can be difficult. The last "seeing" event takes place in the brain. We frequently ignore objects in our environment even though they are visible to us. This typical tendency, which may go unnoticed, is caused by brain processes. It is simple to verify this vision experience. When we look at a site for a while and then try to recall the elements that make up the scene, we might not remember every element. Even though the observer's retina received the light reflecting off the objects in their field of vision, they may not have been sufficiently conscious of all of them to remember them all. Human perception is characterized by this uncertainty. It is most likely because of how the human memory is created and works.

3.5 Material Study

A person's visual perception of architecture is influenced by several factors, including materials, interior design, lighting, façade treatments, and more. This study's methodology has been focused on

examining how materials affect people, which further shapes how they see architecture. The most popular materials today were taken into consideration. The list of the same is provided below.

- Glass
- Exposed Brick
- Stone
- Aluminum
- Wood
- Concrete

All the materials mentioned above underwent a thorough analysis, which included the following:

3.5.1 Glass

Glass is a fascinating substance with so many unique qualities and applications that it has given architects numerous new design options. The usage of reinforced, toughened, and laminated glasses is common among architects in their pursuit of transparency and safety. Additionally, glass is an odorless, sanitary, more durable, and dimensionally stable building material. It is utilized in windows, on facades, and as roofing because of this. This material is used in buildings as transparent dividers in large office spaces or transparent sliding parts in bathrooms and kitchens. Elevators and balcony railings are two other architectural features made of glass. Glass is a material that is fascinating due to its many applications, especially in architecture.



Fig.06, Source: ArchDaily

3.5.2 Concrete

The second-most frequently used material worldwide is concrete. Additionally, manufacturing of cement accounts for 5 to 7 percent of annual emissions, making it the second-largest producer of CO₂. Concrete has been thrust squarely into the centre of innovation and experimentation due to its enduring popularity as a material of choice in the design and construction sector and growing concern over the environmental effects. As a result, several ideas for the potential future of concrete in architecture are being developed by designers,



Fig. 03, Source: Archdaily

Architects and academics all around the world. Roughly 22 billion tons of concrete are poured every year due to its inexpensive cost, adaptability, quick application, and sheer familiarity to those involved in utilizing it. According to a recent BBC analysis, post-World War II construction in Europe and the building booms that began in Asia in the 1990s contributed to the thirtyfold growth in cement production since 1950 and the subsequent fourfold increase since 1990. By 2030, cement production may need to rise by 25% to keep up with demand in Southeast Asia and sub-Saharan Africa.

3.5.3 Stone

Even after 12,000 years, stone is being used in architecture and is as old as civilization itself.

Fig. 04, Source: <https://www.whatshot.in>
the variety of solutions best suited for



contemporary structures and how designers are incorporating traditional elements into modern creations. Stone has been used in architecture since over 12,000 years ago, at the dawn of human civilization. Natural stone still plays a significant role in architecture today because of its various elemental characteristics that add practicality, character, and meaning.

3.5.5 Exposed brick

Any construction gains a distinctive personality from the hues and textures of exposed stone. However, in modern conventional building, plaster and paint are ultimately applied to both sides of the brickwork. Early humans covered up uneven stone and rock stacks with plaster, which is derived from the classical Greek word "emplassein," which meant to "shape or form." Plaster was used to fill up the gaps between uneven surfaces to create cave houses with uniform surfaces. Plaster is now, however, mostly used as an additional layer to hide flaws in better quality and more even cemented masonry construction.



Fig. 05, Source: Archdaily

3.5.6 Aluminum

Not all facades need to be opaque. Previously, the only possibilities were bulky and unpolished, like stone and brick, but in more recent years, façades have taken on a lighter aspect, with novel materials taking the stage. While still preserving Privacy and thermal comfort, these give the structure a new appearance that is delicate and transparent. Polycarbonate, translucent sheets, perforated tiles, glass, and even metal chain links, which was the material picked for a structure in Montpellier, France, are examples of these.



Fig.06, Source: ArchDaily

3.5.7 Wood

Wood is a flexible and affordable material utilised in a wide range of settings and applications. Wood is utilised in many different variations in many different constructions because it has many advantages in design. There is a growing understanding of the value of employing renewable resources in many facets of life, including building and design.

Compared to many other building materials, wood is a renewable resource and requires less energy and Resources to process. The fact that wood has been used in building for a very long time is not a coincidence. It is a remarkably resilient substance that used in building for a very long time is not a coincidence. It is a remarkably resilient substance that may provide buildings a solid framework. In some cases, wood may support its own weight more effectively than other materials like steel.



Fig.07, Source: wikipedia.org

3.6 Photographic Survey

Understanding Visual Perception is necessary for this subject. The best option feasible was to perform a photographic survey based on the residential and commercial building typologies. People were asked to rate which material would be best for the corresponding typologies based on their preferences for the material. Following the display of images of several existing structures in India, the public was also asked which kind of architecture they would most prefer to reside in. Study the reactions of the people indicated by referring to the charts below. (Insert Fig.) The technique of this study has been focused on looking at how people are impacted by materials, which further impacts how they see architecture. Later, it discusses about how effective architecture must be in providing people with visual comfort and appeal.

3.6.1 Data Collection and Analysis

Following are the parameters taken into consideration while taking the survey:

- Colour
- Form & Shape
- Materials & Texture
- Aesthetics
- Interiors
- Heights & Volume
- Value
- Nature

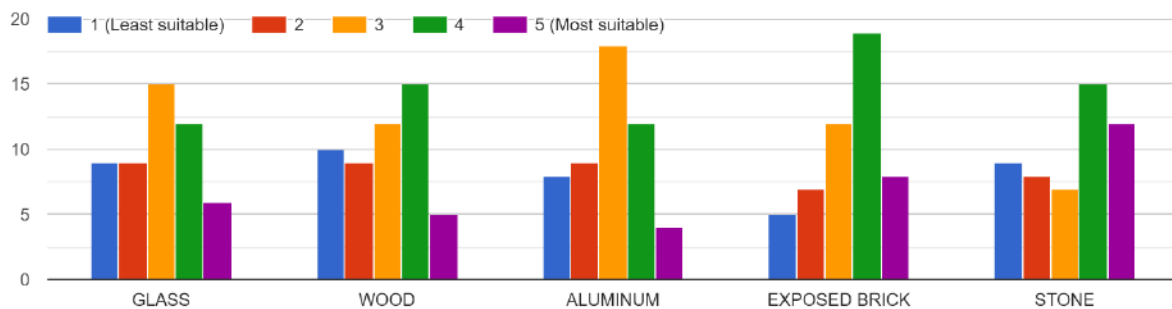


Fig. 08 (Referred from Google form)

People were also questioned regarding their preferences based on the residential and commercial typologies. People could decide which material or building was more aesthetically pleasing and would capture their attention first after being shown photographs of residential structures made of various materials. When asked which material they thought would be best for residential constructions, the majority of respondents indicated stone. This naturally references the fact that stone was one of the best building materials in use in ancient times. It is clear that the emphasis should be placed more on inculcating the use of the material in conjunction with emerging technology. (Refer Fig. 02)

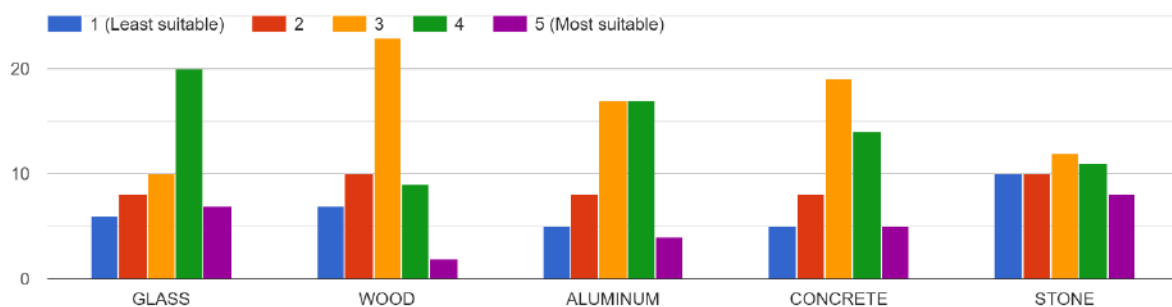


Fig. 09 (Referred from Google form)

Similarly, the respondents agreed that glass was the material that would work best for commercial structures. When utilized on building facades, glass offers a sleek, modern look that gives architects many design options. Due to its unique qualities and benefits, glass is widely employed in commercial structures. Therefore, this section of the survey discusses several advantages of using glass in construction. (Refer Fig. 03)

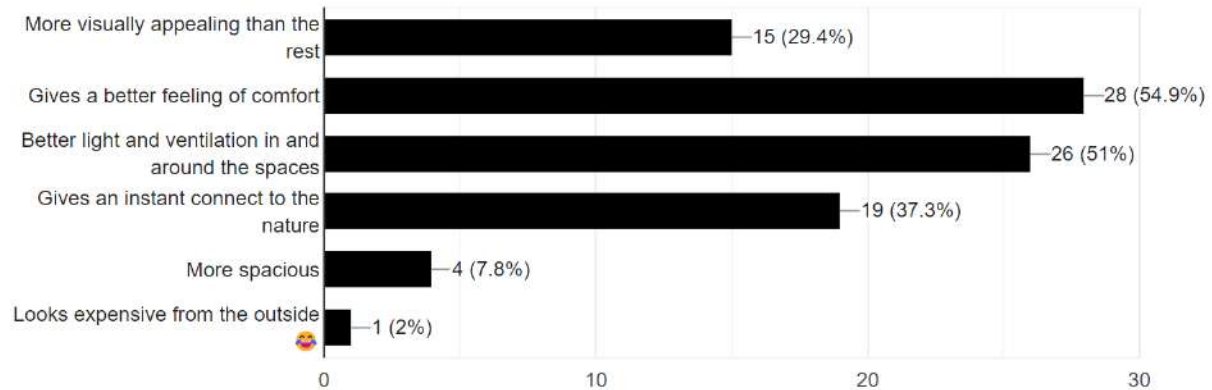


Fig. 10 (Referred from Google form)

It was shown that the majority of people first think of light, ventilation, and an instant connect to nature when they first see a building. The amount of light and ventilation in and around the building, how the façade is treated, and how you integrate the outside environment with the building all become crucial factors since they communicate to the observer what and which aspects are more significant. (Refer Fig 01)

4. Results and discussions

The perspective of common man towards architecture changed with time and that change brought about some impolitic breach between them. This can be seen from the works of famous architects of any time between ancient and contemporary periods. It is also observed that this schism grows from ancient to contemporary and to obviate it, the cause of this change in vantage point must be eliminated. Some examples in the history of architecture appropriately represent the gap in actual architecture and the apprehension of common man. For instance, modern architecture comprised of two typologies viz. The rationalist architects who were too engulfed in form, function, classicism and rudimentary principles and the architects of art nouveau on the other hand who were focused on biometric and sensitive architecture. This severance was between the thoughts of architects, so the common man would already be put into perplexity. On the other hand, Visual communication which comprises of graphic communication plays a great role in the same because the visuals are the best you have retaining the information in the human mind. If all buildings have their own dance, then it would turn into a hideous aura and that harmony and serenity of the place would be lost which ones seemed to be united due to a rhythm in the build forms. How far is the use of architectural vocabulary justified in order to glorify the beauty of the build form? Keeping in mind that use of these articulated words is assessable by a limited part of society i.e., only the architectural fraternity, why the beauty of structures can't be glorified by using a language that even a common man can understand as well as appreciate.

5. Conclusion

The need for this has become more and more apparent in developing economies around the world, where unfamiliar alien forms are obtruding on the skylines of numerous towns and cities and are incomprehensible to the local population. Towns and cities are becoming more separated as a result,

and the social fabric is deteriorating. Therefore, it is becoming more important than ever to communicate with people about this new architectural trend. The art, history, and culture of a period are significantly influenced by communication. And as was already mentioned, architecture is used to represent them all. In order to preserve the illustriousness and elevate the beauty of architecture, effective and pertinent communication across all media is the best resource. In all this, proficient written communication helps in conveying the articulate nature of architecture to the layman and developing in him the sense of curiosity to apprehend and explore the magic and beauty of the same. Albeit there elicits a question, would improper communication affect the dandyism of architecture, decorous perception and observance will never fail to appreciate its beauty and shall always value its position in framing the culture and tradition of any realm.

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The applicability of computational technology as a facilitator in preserving or reconstructing the existing Chennakesava temple at Belur.

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Abstract: The Chennakeshava Temple is 12th century temple located in Karnataka. This star-shaped temple is also referred to as Keshava or Vijayanarayana Temple of Belur and is one of the renowned temples of Hoysala. It is believed to have taken around 103 years to build. Temple is also proposed to be listed under the sites of UNESCO World Heritage. The main temple had a shikhara (superstructure tower) but now it is missing, due to which the temple looks incomplete. Using shape grammar, and a parametric theory, the architectural language of the temple can be replicated and used to redesign the shikhara. In shape grammar, a set of rules is developed to create a particular shape pattern. To replicate Chennakeshava Temple's architectural language, basic principles of shape grammar like translation, Rotation, Scale, Reflection, and combination are used. In this research paper, a set of rules has been developed to respond to the geometrical language of the temple. These sets of rules and geometrical patterns will be created with the help of computational methods such as grasshopper. The set of rules created will be used to propose the missing shikara design.

Keywords: Chennakeshava Temple, Shikhara, shape grammar, parametric theory, grasshopper

1. Introduction :

Indian temples there are mainly classified into three styles namely Nagara (north Indian), Dravida (south Indian), and Vesara (hybrid). This research limits itself to only one style, i.e. Dravida, especially in Karnataka, one of the reasons being the availability of well-documented information and drawings. . This study will analyze the use of shape in the design development of Dravidian temples in Karnataka through a timeline.

Starting period around 3 BCE with the Dynasty of Shatavahana, which had main rulers Semukha, and Gouthamiputhra, which was an empire extending to Deccan comprising present Andhra, Karnataka, Maharashtra, to the present day of Karnataka State Government to the Whole of Karnataka. So between this timeline, there were many dynasties in Karnataka, At CE.1000 - CE.1346 the period / Era was the Hoysalas Dynasty which was known as Hoysala of Dwarasamudra with the main rulers of Vishnuvardhana / Ballala II.

The Hoysala were great patrons of art. In architecture, a remarkable achievement has been seen in this era. Various sculptors, architects, and other artisans worked together as a group to flourish the rich and vibrant temple tradition in South India. Specialized professional groups of these artisans constructed the temples. As these artisans travelled across kingdoms, the architectural and sculptural knowledge was spread from one dynasty to another. The major innovation during the Hoysala era was the exquisite embellishing of the temple exteriors by extremely fine sculpture.(A.P. SINGH,2021).in this era and under the rulers of Vishnuvardhana / Ballala II, many temples and temple complexes were built, like Lakshmidewit temple with the deity of goddess Lakshmi at Doddagaddavalli in CE.1113, Chennakeshava temple with the deity lord Vishnu at Belur in CE.1117, Hoysaleswara temple with the deity lord shiva at Halebidu in CE.1120, and etc.

The Chennakeshava Temple

The temple complex was built at the center of the old walled town and took over three generations – 103 years – to complete. It has been repeatedly damaged and plundered during wars, and repeatedly rebuilt and repaired over its history. Also referred to as Keshava, or Vijayanarayana Temple of Belur is a 12th-century temple in Karnataka and one of the bigger and more renowned Hoysala temples. King Vishnuvardhana commissioned the temple in 1117CE after his victory in the great battle of Talakkad. It is situated on the banks of the Yagachi River in Belur, also known as Velapura. In later inscription the Hoysala was revered and referred to as “Vaikuntha on the earth” (abode of vishnu’s)and “Varanasi of the Dakshina”(The holy city Southern) . The city Hoysala had Belur as first capital.

Keshava or the Chennakesava , is the one of Vishnu forms. It is the one of active Hindu temple in Karnataka since its consecration. The shikhara of the main temple which got demolished due which superstructure tower of the main temple is missing, and the temple looks flat. The shikhara or original vimana was built by using mortar and bricks supported by woodwork which was plated with copper and gold-gilded sheet. It had to be dismantled during the early 19th century to save the damaged inner sanctum. The temple is small and complete in all aspect with sanctum (garbha griya)and nine square hall(navaranga)with fifty-nine large reliefs on the outer walls. Which is dedicated to lord Brahma, lord Vishnu, lord shiva and angry shiva (lord Bhairava),goddess Sarawati ,goddess Lakshmi, goddess Parvati and other. The story of Bhima form Mahabharata is depicted on some panels.Because of the pattern, shape-building logic, and generate design, one of a parametric theories which are known as shape grammar theory can be used to study or analyse the temple.

shape grammar

A shape grammar is a set of shape rules that apply in a step-by-step way to generate a set, or language, of designs. Descriptive and Generative both are in shape grammar. The set of rules of a shape grammar compute or generate designs, and the rules themselves are representation of the forms of the generated designs.

Stiny and Gips both of them invented the Shape grammar. The earliest systems of algorithm for comprehension and creating designs directly through computations with respect to shapes ,rather than indirectly through computations with symbols or text. During the years the theory of shape grammars have been explored and which address a variety of design problems

Shape grammar theory and applications are well documented and represented in the literature on design computation and related areas. A shape grammar is a set of shape rules that apply in a step-by-step way to generate a set, or language, of designs. Shape grammars are both descriptive and generative. The rules of a shape grammar generate or compute designs, and the rules themselves are descriptions of the forms of the generated designs

2. Methodology :

This research is taken forward in a qualitative approach with the following components: literature-based study initially, case study analysis, generation of the parametric model followed by experimentation through computation.

The methodology is summarised systematically

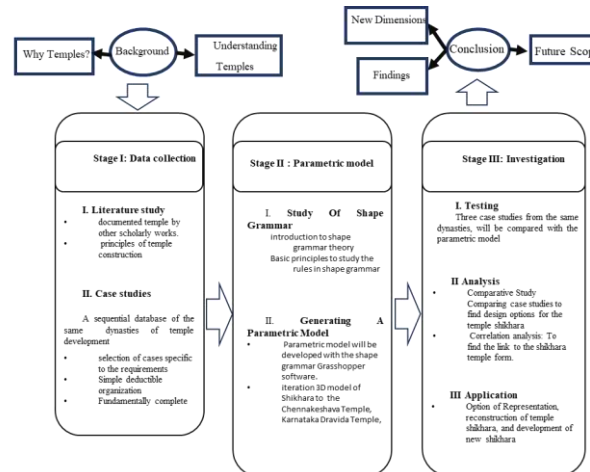


Figure 1 The three-stage methodology of the research. (Source Author)

3. Case Studies

Karnataka Dravida tradition began and matured entirely during the reign of the Early Chalukyas (Hardy, 1995). A few temples from Hoysala Dynasty three temple are studied in order to justify the reconstruction of temple shikhara.(Lakshmidewit temple at Doddagaddavalli in CE.1113, Figure 2)and(Veera Narayana with the deity lord Vishnu at Belavadi in 1200 CE. Figure 3)(Hoysaleswara temple at Halebidu in 1120. CE, Figure 4) ,(Chennakeshava temple at Belur in 1117.CE Note: Only the Hoysalas Dynasty era temples are chosen throughout the tradition in order to maintain uniformity in understanding the geometric principles.

Table 1 Case study of 3 Hoysala Dynasty era.(Source by Author)

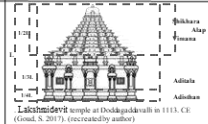

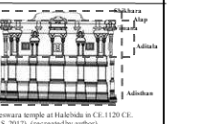


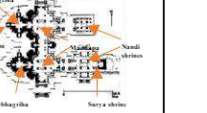
Temples:	1.Lakshmidewit temple at Doddagaddavalli in 1113. CE	2.Veera Narayana temple at Belavadi in 1200 CE	3.Hoysaleswara temple at Halebidu in 1120. CE.
Elevation of temples:	 Lakshmidewit temple at Doddagaddavalli in 1113. CE. (Goud, S. 2017). (increased by author)	 Veera Narayana with the deity lord Vishnu at Belavadi in 1200 CE. (Goud, S. 2017). (increased by author)	 Hoysaleswara temple at Halebidu in CE.1120 CE. (Goud, S. 2017). (increased by author)
Existing Plan of temples:	 Figure 1.1. Lakshmidewit temple at Doddagaddavalli in 1113. CE. (Goud, S. 2017). (increased by author)	 Figure 2.1. Veera Narayana with the deity lord Vishnu at Belavadi in 1200 CE. (Goud, S. 2017). (increased by author)	 Figure 3.1. Hoysaleswara temple at Halebidu in CE.1120 CE. (Singh, Rana. 2017)
Plan Forms:	The temple square plan in the outer periphery and the temple has four small shrines at the edge of the outer periphery, this design is called parivaralayas in Sanskrit texts.	The temple has three separate square sanctums connected through an unusually large square rangamandapa. The plan of the temple is unique in that two of the shrines face each other and are located on either side of a wide and spacious open mandapa containing thirty-seven bays. Both have a square sanctum, with one shrine square in shape as well while the other is star-shaped (stellate).	The temple also called as Hoysaleswara or Hoysaleswara temple, is a twin-temple, or dvikuta vimana (plan with two shrines and two superstructures). The two temples are of the same size, and their sanctums open to the east, being sunrise.
Organization Composition	Consists of the garbhagriha and subsidiary shrine and an attached mandapa.	Consists of the garbhagriha and two of the shrines facing each other and an attached mandapa (pillared hall) and porch, have three different shikhara.	Consists of the two garbhagriha, two Nandi shrines and an attached mandapa (pillared hall) and porch, which have flat shikhara
Vimana Composition	it Consists of direct phamsana-style tower shikhara after adithala first tala Adithana(plinth) Second tala Adithala(cellar/garbhagriha)	it Consists of directly Veera superstructures style shikhara after adithala first tala Adithana(plinth) Second tala Adithala(cellar/garbhagriha)	it Consists of direct dvikuta vimana (flat shikhara) after adithala. first tala Adithana(plinth) Second tala Adithala(cellar/garbhagriha)

Table 2 Table 2.Inferences from Case Studies.(Source by Author)

The temple element	Attribute	Parameter of attribute
Temple in 2D	Garbhagriha the centre point	Projection system in the plan, Nirandhara or sandhara.
Temple in 3D	Components of shikhara	Adisthana, aditala , shikhara.
Arrangement of spaces	Composition of the temple with respect to the functional spaces	Vimana , mandapa , entrances porch and nandi mandapa.

4. Parametric model

4.1 Parametric model

Basic principles to study the rules in shape grammar

- A shape rule defines how an existing (part of a) shape can be transformed.
- A shape rule consists of two parts separated by an arrow pointing from left to right. The part left of the arrow is termed the Left-Hand Side (LHS).
- It depicts a condition in terms of a shape and a marker. The part right of the arrow is termed the Right-Hand Side (RHS). It depicts how the LHS shape should be transformed and where the marker is positioned

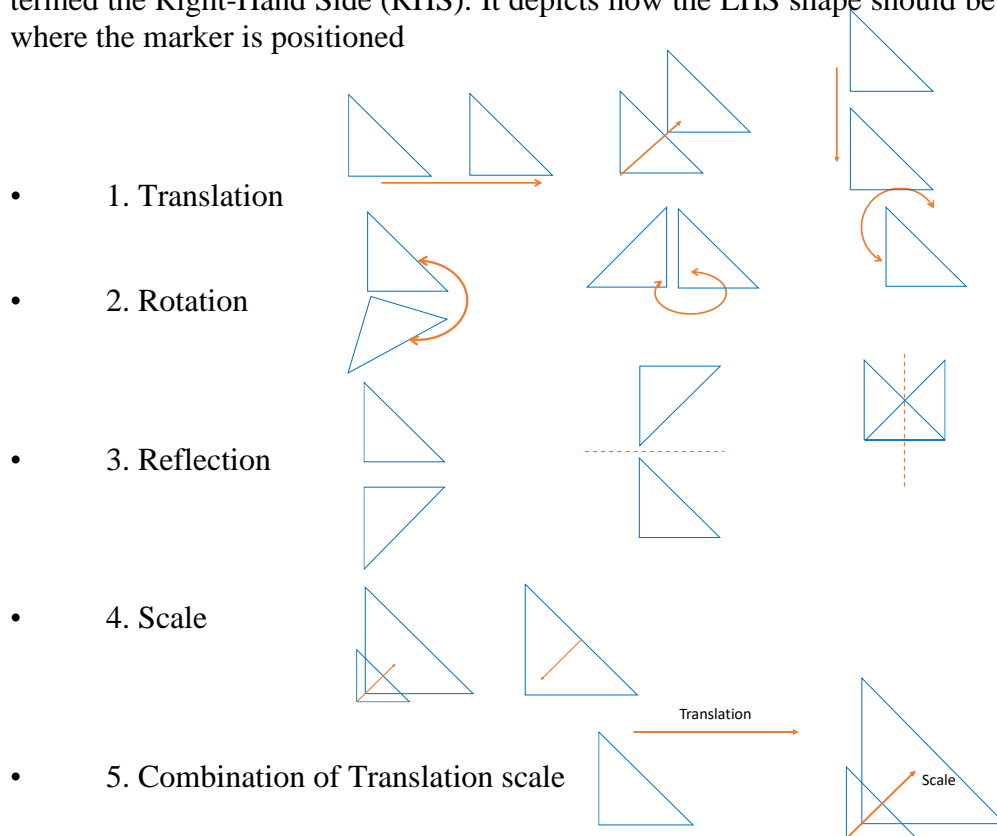


Figure 1 Basic principles and the rules in shape grammar.

4.2 Analytical Parametric model

4.2.1 Lakshmidēvit temple with the deity of goddess Lakshmi at Doddagaddavalli.



Figure 2 Lakshmidēvit temple with the deity of goddess Lakshmi at Doddagaddavalli .(Brig A.P. Singh June 23, 2021).

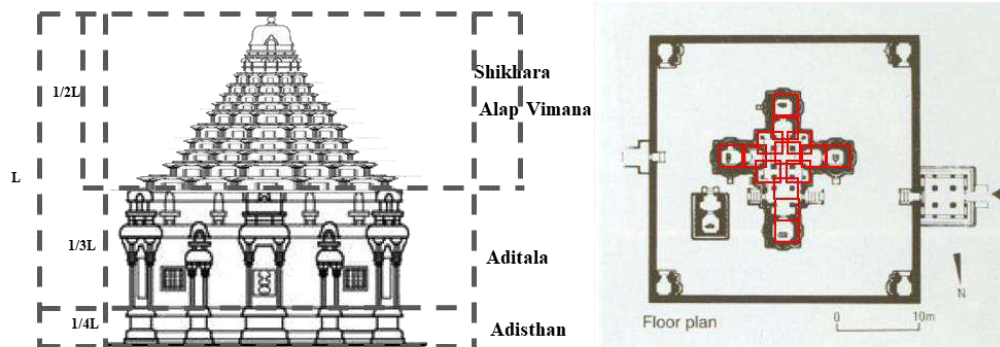


Figure 3 Elevation of Lakshmidēvit temple at Doddagaddavalli . (Goud, S. 2017). Plan of Lakshmidēvit temple Doddagaddavalli (n.d.)(Doddagaddavalli Fort is Peculiar Architecture in Karnataka | BangaloreOrbit) (recreated by author).

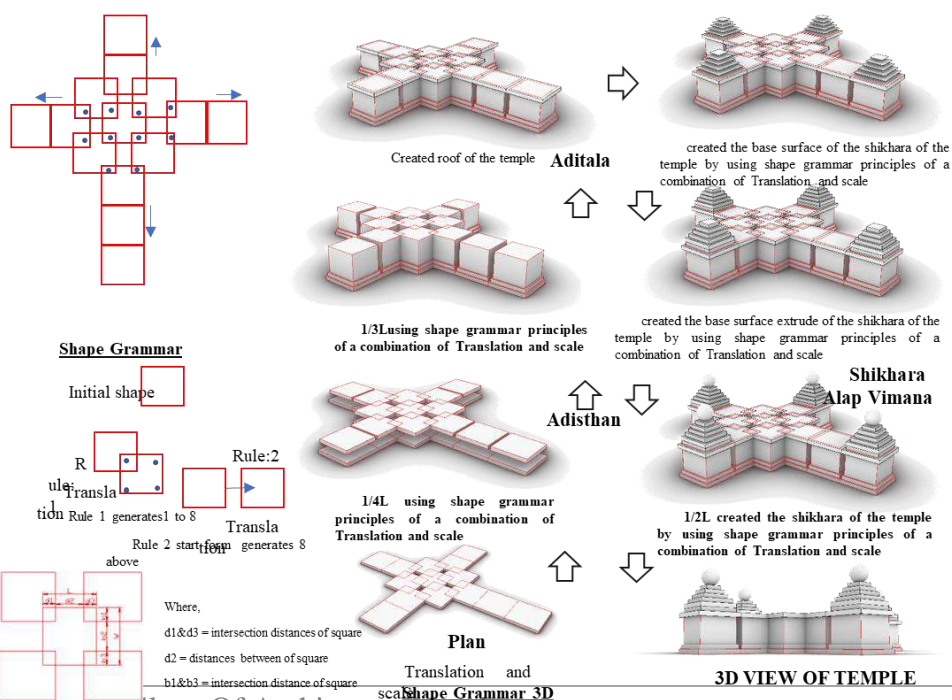


Figure 4 Analytical Parametric model of Lakshmidewit templeat Doddagaddavalli (by author)

4.2.2 Veera Narayana with the deity lord Vishnu at Belavadi.



Figure 5 VeeraNarayana with the deity lord Vishnu at Belavadi
(photo: Katherine E. Kasdorf; CC BY-NC-SA 4.0).

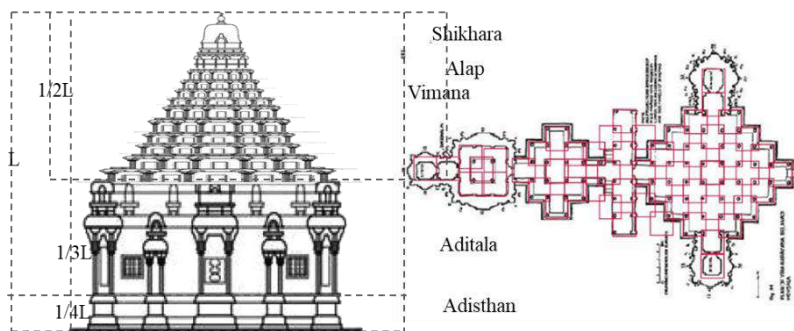


Figure 6. Elevation Veera Narayana with the deity lord Vishnu at Belavadi (Goud, S. 2017).

Plan of Veera Narayana with the deity lord Vishnu at Belavadi in 1200 CE. ("Veera Narayana Temple, Belavadi, Chikmanguluru, Karnataka," 2020). (recreated by author).

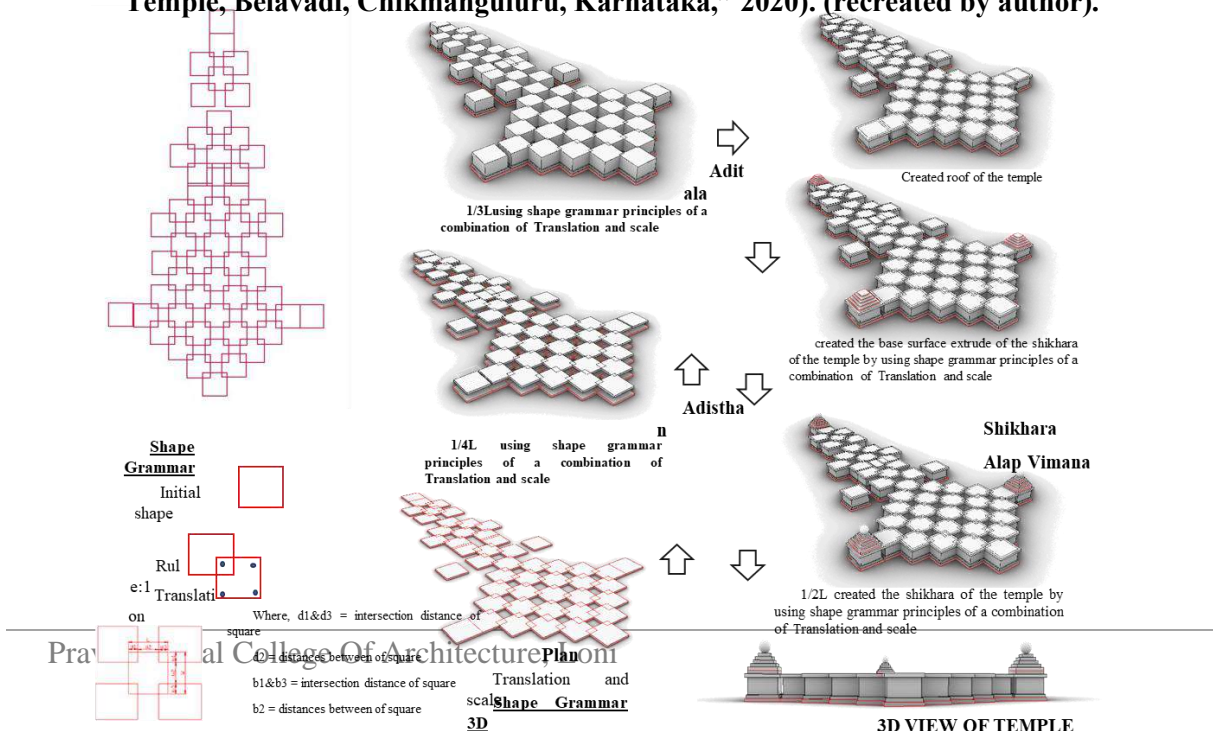


Figure 7 Analytical Parametric model of Veera Narayana at Belavadi (by author)

4.2.3 Hoysaleswara temple at Halebidu



Figure 8 The Hoysaleswara temple at Halebidu (photo: Katherine E. Kasdorf; CC BY-NC-SA)

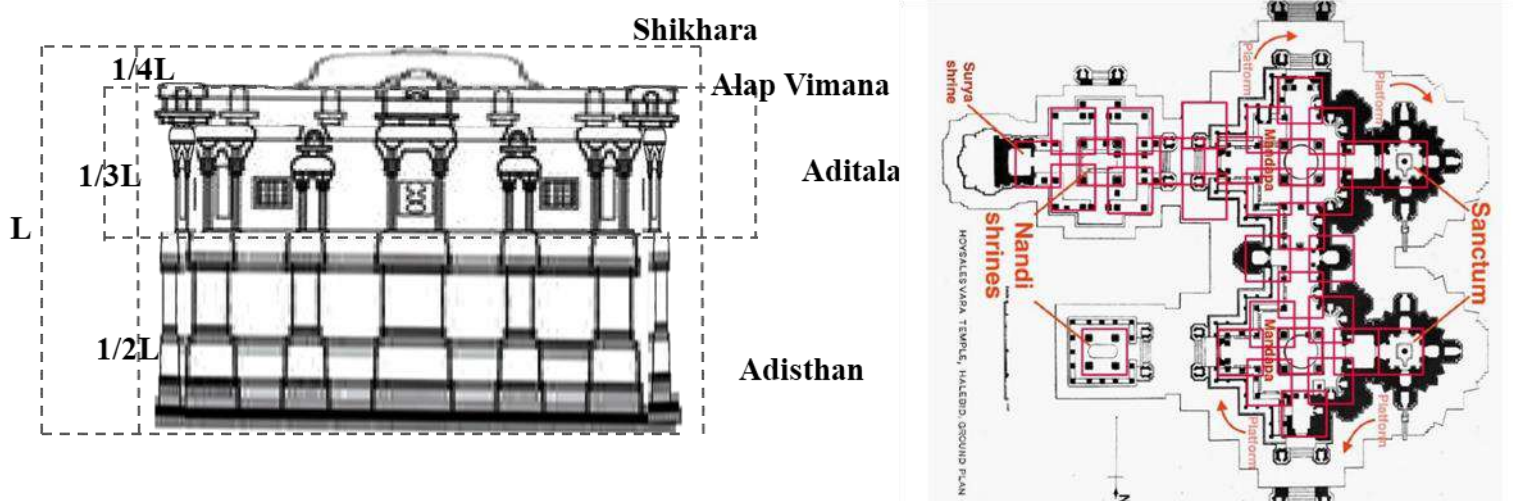


Figure 9 Elevation and plan Hoysaleswara temple at Halebidu . (Goud, S. 2017). (recreated by author)

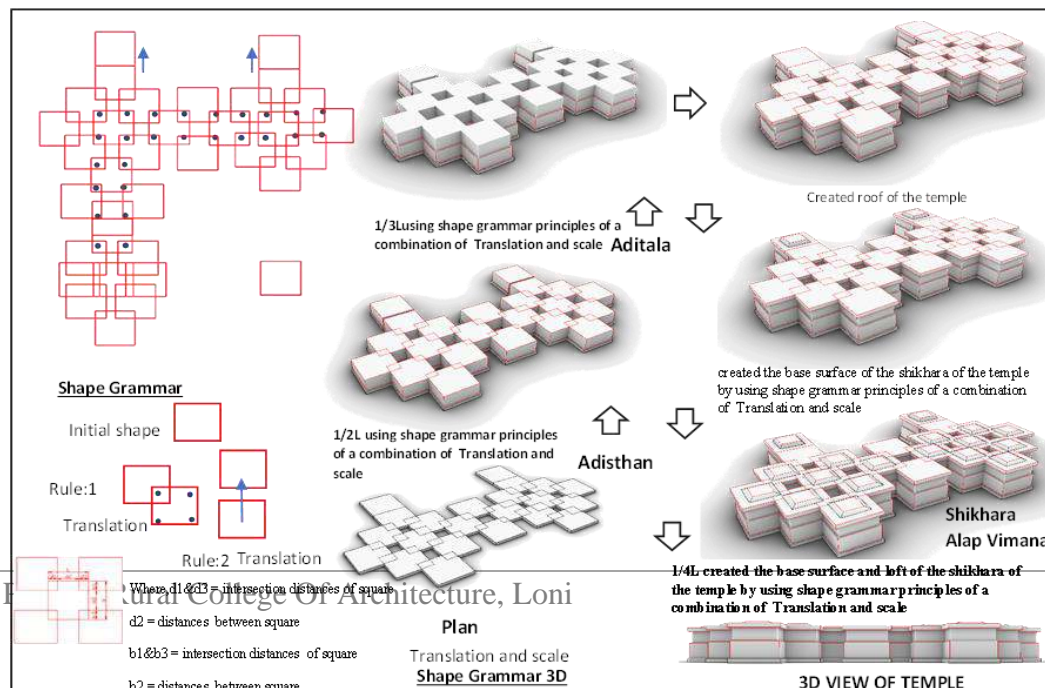


Figure 11 Analytical Parametric model of Hoysaleswara temple at Halebidu (by author)

Table 2 Inferences of analytical Parametric model from Case Studies.

Temple Name	Temple Shikhara	Shikhara(L)
Lakshmidewit temple	phamsana-style tower	Shikhara is $1/2L$
Veera Narayana temple	<u>Vesara</u> superstructures (shikara)	Shikhara is $1/2L$
Hoysaleswara temple	Flat superstructure towers	Shikhara is $1/4L$

According to the parametric analysis in the above 3 case studies, the Dravidian style of Karnataka in the Hoysalas Dynasty era temples, The parametric theory of shape grammar is applicable, using shape grammar theory to create the Chennakeshava temple shikhara (superstructure tower) which is missing.

5Application of the Model



Figure 12. Chennakeshava temple with the deity lord Vishnu at Belur.(By Anuradha Goyal- November 25, 2019).

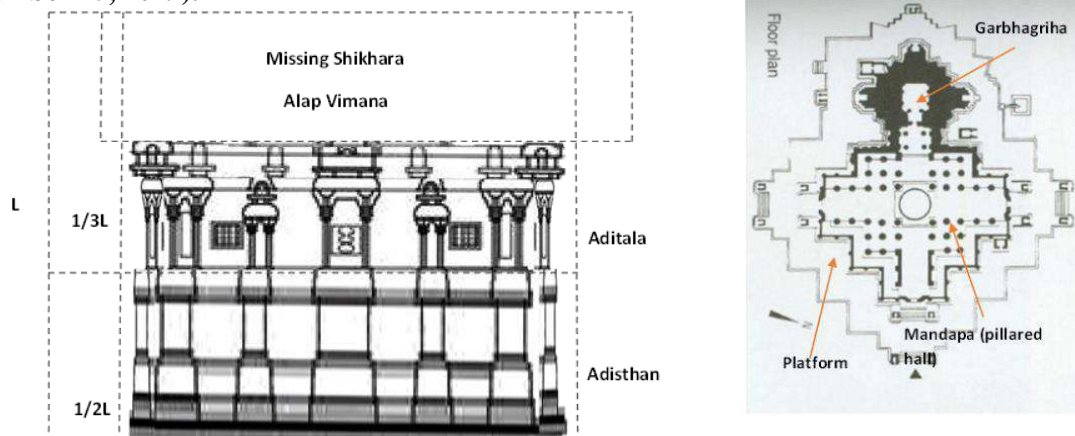


Figure 13 Elevation of Chennakeshava temple at Belur.(Goud, S. 2017). (recreated by author)
Plan of Chennakeshava temple at Belur (n.d.)(Belur Fort is the famous tourist destination
Architecture in Karnataka | BangaloreOrbit).

5.1 Analytical Parametric Model

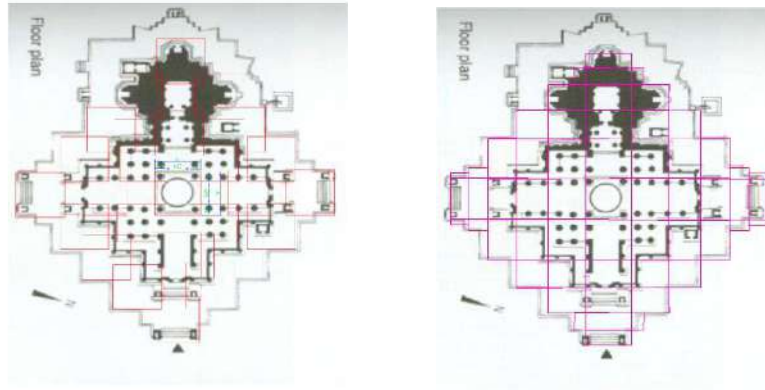


Figure 14 Two options of shape grammar in Plan of Chennakeshava temple at Belur (n.d.)(
Belur Fort is the famous tourist destination Architecture in Karnataka | BangaloreOrbit)
(recreated by author).

5.1.1 Option 1 Analytical Parametric Model.

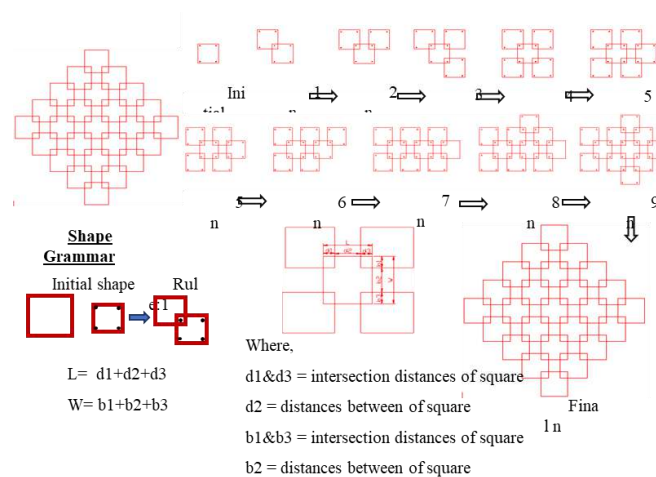


Figure 15. using shape grammar principles and the rules created existing Plan of
Chennakeshava temple. (created by author).

5.1.2 Option 2 Analytical Parametric Model

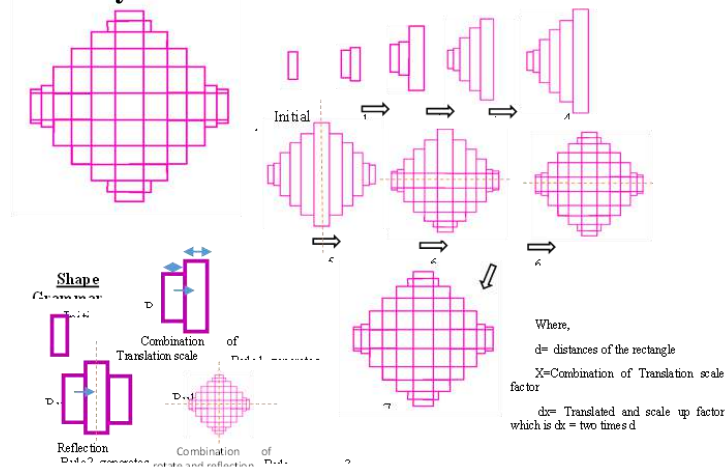


Figure 16 using shape grammar principles and the rules created existing Plan of Chennakeshava temple. (created by author).

5.2 Inferences from Analytical Parametric Model.

According to the parametric analysis in the above two options, (Figure 17 and Figure 18) the parametric theory of shape grammar is applicable, According to the parametric analysis in the three case studies form (Figure 5, Figure 8 and Figure 12) which have same principles and rule (Translation) of shape grammar ,Which have logic of ($L = d_1 + d_2 + d_3$ and $W = b_1 + b_2 + b_3$) and the same logic and principles of shape grammar can be used to create the Chennakeshava temple shikhara, so option 1 (Figure 17) is more applicable to Chennakeshava temple.

5.2.1 Application of the Model Option 1

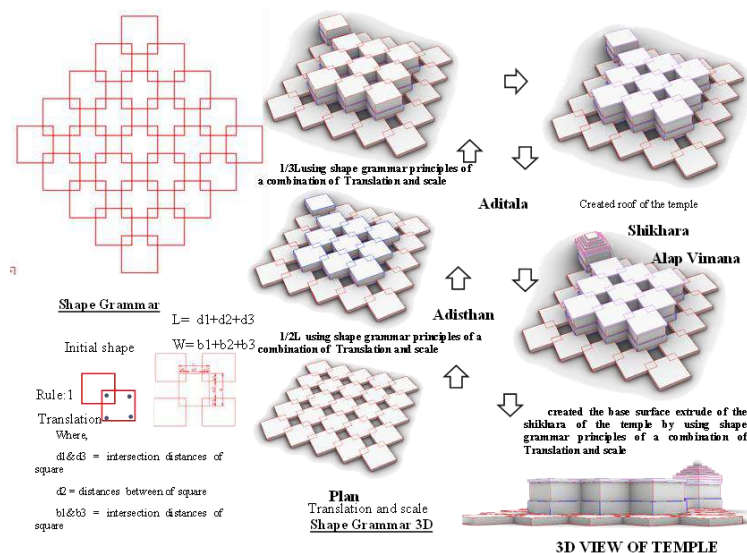


Figure 10 Analytical Parametric model of Chennakeshava temple by using the shape grammar which was used to (figure 5 and figure 8) (by author).

5.2.2 Option 2

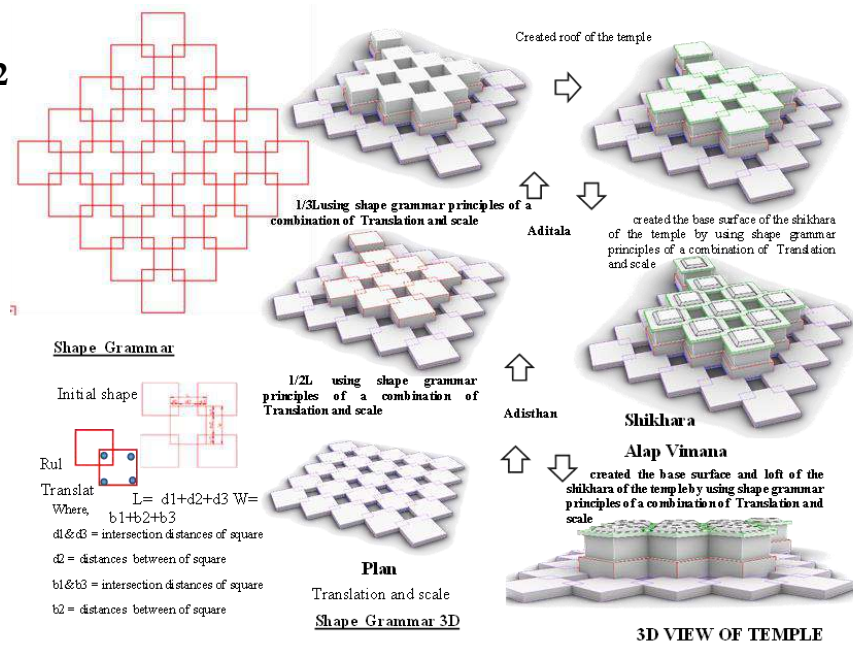


Figure 18 Analytical Parametric model of Chennakeshava temple by using the shape grammar which was used to (figure 11) (by author)

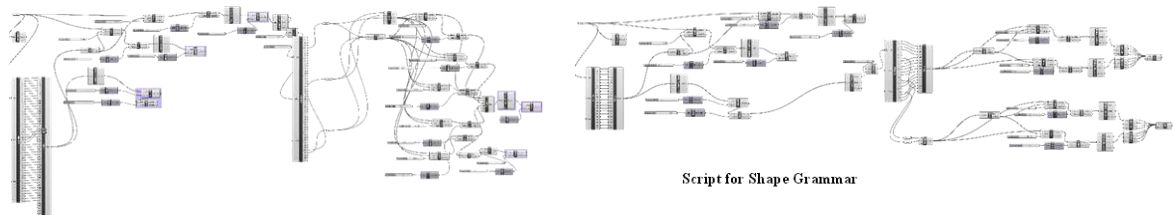


Figure 19 script of grasshopper for shape grammar used for (figure 5, figure 8, figure 11, figure 17, figure 18 and figure 20) (by author)

5.3 Application

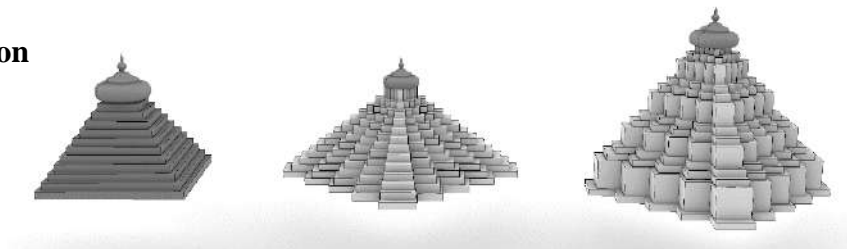


Figure 20 iteration 3D model of Shikhara to the (by author)

5.3.1 Options



Figure 21 Option 1 using shape grammar and created shikhara According to the phamsana-style tower which is (1/2L) of temple.(by author)

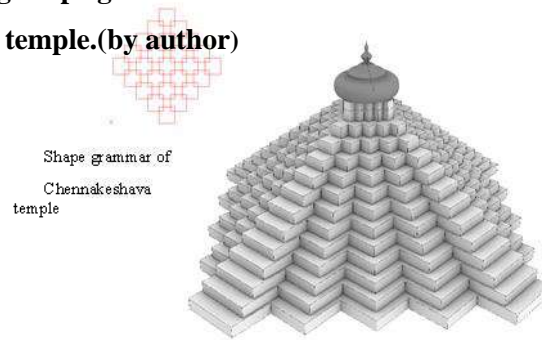


Figure 11 Option 2 using shape grammar and created shikhara According to the phamsana-style tower which is (1/2L) of temple..(by author)

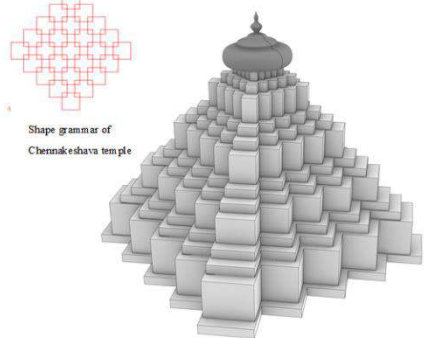


Figure 23 Option 3 using shape grammar and created shikhara According to the Vesara superstructures (shikara) which is (1/2L) of temple..(by author)

6 Discussion

The major role of shape which contributes according to above case study and Analytical Parametric model, in such as the Hoysalas Dynasty era temples, which establishes a relationship between shape grammar and Indian temple architecture of Hoysalas Dynasty era temple. A mathematical and logical relation is inferred from the existing design between the plan of the temples. Though, it does not definitively justify its role in the evolution, but infers a relation which would be helpful in restoration and reconstruction of Karnataka -Dravid temple. Hence, the application of shape grammar theory and its computation can open an excessive amount of opportunities in not only studying the existing building but also in creating a new logic and new pattern. The factor that can be derived by the above statement is that, the interest to study the design should not be restricted in area of planning characteristics, but should also be studied in conjunction with the elevations. Therefore, the possibility or the question that needs to be explored is, the desired result of the parametric model in the restoration of existing designs. This research definitely raises a few relevant questions considering the heritage and rich culture of India exhibits as follows:-

1. Can Parametric theory and computational tools be a media to preservation or reconstruction of existing temples and still maintain the creative liberty?
2. Is Reconstruction or restoration of Indian temples to the current scenario justifiable to do?

7 Conclusion

According to the all Inferences from Case Studies, parametric analysis and parametric model, it shows the application of Representation, reconstruction of temple shikhara, and development of new shikhara. the best option of shape grammar is fig. No. 26 Option 3. The parametric theory and

parametric model both show the abundant results to understand the role and relevance of shape grammar and logic in temple evolution. The chronology of the evolution of architectural planning and components can also be tested from the model. With the shape grammar which facilitate to develop not only logical patterns but also the mathematical relation in shape building process, and support creating generate design. Entertaining the idea of each of these inference individually and later combining their contextual translation defiantly shows the shape grammar significance in typology evolution.

7.1 Future Scope Of Research

Considering the design of ancient Dravidian temple, there are severe levels of complexity constructed during the Hoysalas Dynasty, the parametric theory and model raises a concern to its applications in the analysis and applicability on ornamentation being in holding such a complexity. This research can be at both level, macroscopic and microscopic development. Having a successful and logical establishment of a script which would also facilitate in generative design, not only in the revolutionary, but also in the way of documentation of Indian temple architecture in current.

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Developing equilateral triangle mesh for a doubly-curved surface geometrically in grasshopper for easy and cost-effective fabrication

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Abstract : Introduction of CAD/CAM technology has transcended architectural character from rigid geometries to organic form. For aesthetics, many architectural structures feature doubly-curved surfaces. The first step of the fabrication process is flattening or planarizing the three-dimensional design surface into a planar shape that can be fabricated by the manufacturer. This is commonly done by triangulation of the surface which result in triangles with different dimensions which are difficult to fabricate and must be customized.

The aim of this research paper is to make the fabrication cost-effective and easy. To achieve this, an equilateral triangular mesh will be developed on the doubly curved surface by using computational methods and tools such as rhino and grasshopper. This process of logic-building and scripting the doubly-curved surface into equilateral triangles with same dimensions on grasshopper geometrically, without using physics engine like kangaroo, is developed for getting result which is more accurate and time-saving. This paper will help to evolve a method which will lead to cost-effective and easy mass-production & fabrication of the doubly curved surface.

Keywords: Doubly-curved surface, Grasshopper, Fabrication, Triangular mesh,

Logic-building

Introduction :

1.1 Evolution of Digital Fabrication

The term "digital fabrication" describes the machine-building process that is managed by technical/mechanical tools like computer system. Emerging technology of computer-aided design, commonly referred to as CAD and computer modelling software, is used during the manufacturing process of intricate details on any structure. Here are two methods of fabrication mainly subtractive method namely known as Computer numerical control (CNC), as the name suggests this manufacturing method eliminates the material. The other method of manufacturing is additive method also known as rapid prototyping (RP), in this typology the layers of a material are laid on top of each other to create a complete module/ structure.

As a result, there are many different types of digital fabrication techniques that includes CNC machining, laser cutting and 3D printing. The laser-cut method is a subtractive form of manufacturing that works with a variety of materials, including matte board, chipboard, wood, and acrylic sheets. Depending on the material properties the intensity and other modifications are made in pre - settings to achieve a specific output. (Sojo, 2022b) The concept of digital fabrication has been developed in the design sector, and it has enabled creative designers to take a different approach to design.

Building features that satisfy architects' demand for creative freedom and practical solutions was made possible by the use of digital manufacturing in architecture. By additive or subtractive procedures of digital fabrication helps the designers to reevaluate and imply the original idea of designs with minor tweaks in their design processes. As a result, these new manufacturing techniques help with complex designs to make efficient, long-lasting solutions more easily available. Architects have been trying to explore new material expressions and alter what is currently known as Modern architecture.

Introduction of technology into the building industry has given architects opportunities for design explorations and make the production easier. The new trends of construction held with new manufacturing techniques have led to the development of new systems. These new systems help architects to focus on aesthetics of the buildings that can be achieved using new materials and better building components.

1.2 Traditional Fabrication of Doubly Curved Surfaces

Doubly-curved structures are widely used in architectural design concepts. However, engineering this structure into buildable parts and optimizing it to derive a best solution between the architectural requirements, structural costs and stability is a difficult task. To make the doubly-curved surface buildable, the common method used is to discretize the surface geometry in planar triangular meshes. (Challenging Glass 4 & COST Action TU0905 Final Conference, 2014, p. 133-134). In this method, the triangles derived are of different dimensions and sizes. Each triangle is then numbered according to its position. These are then custom fabricated one-by-one, arranged in the order and assembled by the edges or vertices as per the design and the numbering.

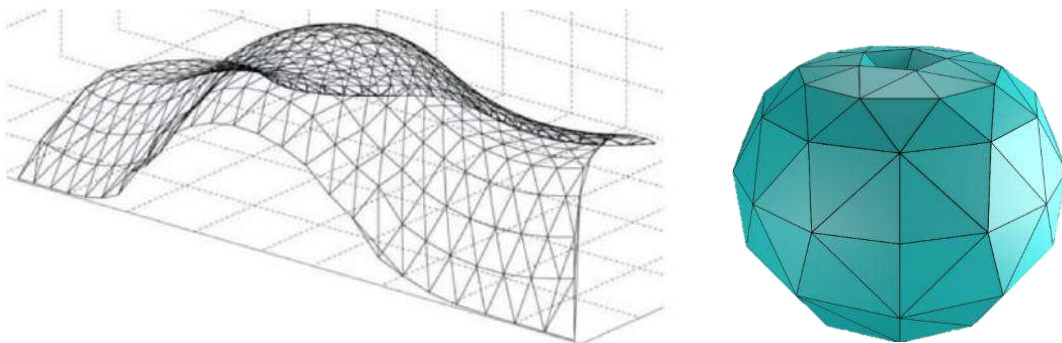


Figure 2.1 : Triangulation of doubly curved surface (traditional)

2 Methodology

Quantitative approach has been used in this research paper. Using geometrical method to achieve is of major importance to achieve the equilateral triangle mesh on the doubly curved surface. The output is achieved by using computational methods in Rhinoceros, by developing a script in Grasshopper.

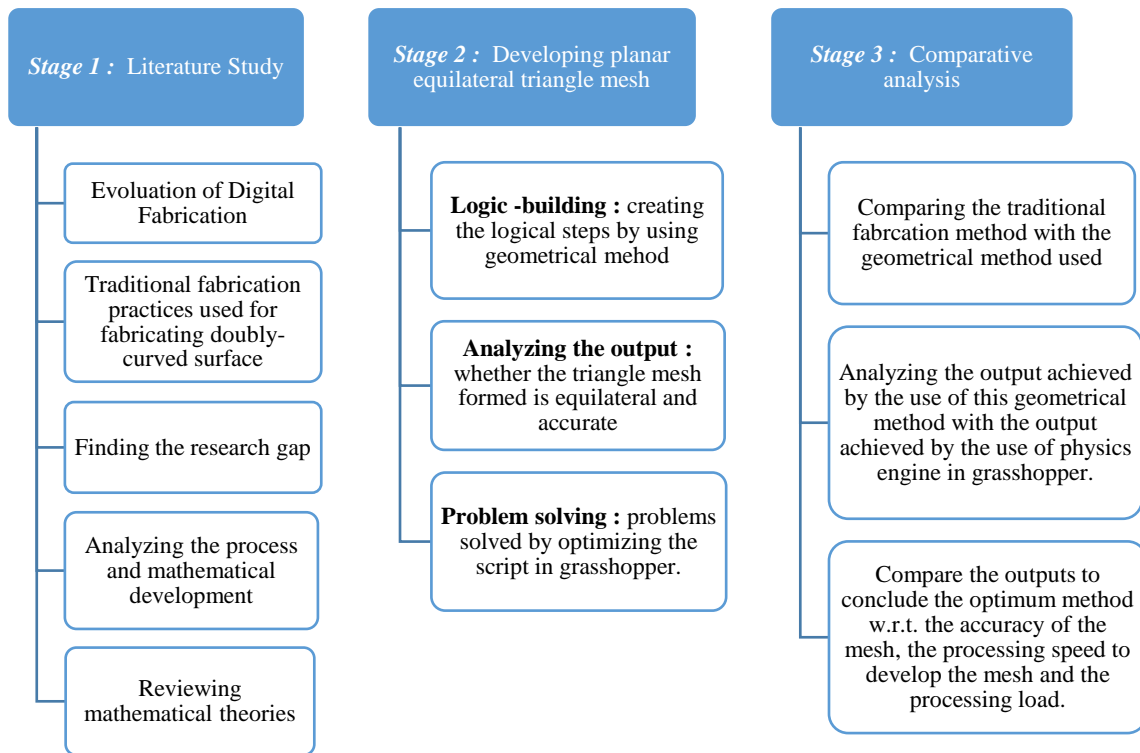


Table 2.1 : Methodology of research

2.1 Stage 1: Literature study

- Review the traditional practices and existing exploration done to achieve fabrication of doubly curved surface.
- Analyzing their process and mathematical development to achieve the end result.
- Reviewing mathematical theories which can be applied to develop an equilateral triangle mesh on the doubly curved surface.

2.2 Stage 2: Developing equilateral triangle mesh

The triangular mesh is developed by using geometrical method instead of physics engine. This stage is based upon exploration & trial and errors.

- Logic-building –
Creating the logical steps by using mathematics as a base to achieve the equilateral triangle mesh.
- Analyzing the output –
Whether the triangle mesh formed is equilateral and accurate (whether the edges of the triangle are connected or having gaps in between)
- Problem solving –
If there are any problems detected while analyzing the output, the problems must be solved by optimizing the script in grasshopper.

2.3 Stage 3: Comparative analysis

- Analyzing the output achieved by using this geometrical method with the output achieved by the use of physics engine in grasshopper.
- Compare both the outputs to conclude the optimum method with respect to the accuracy of the mesh, the processing speed to develop the mesh and the processing load.

3 Developing planar equilateral triangle mesh

This research paper approaches to derive a planar equilateral mesh on the doubly-curved surface, to make the fabrication easy and cost-effective. This will be done with the help of Rhinoceros software by using Grasshopper (for node-based scripting).

One method to achieve this is by using physics-engine like kangaroo for grasshopper. It will create this mesh by the help of gravitational force. Achieving this result by using kangaroo proves that developing an equilateral triangle mesh for a doubly curved surface is possible to create. The limitation of using kangaroo physics engine is that refresh rate and calculations is a slow process. Also, kangaroo being a plugin for grasshopper needs to be installed separately which makes the process tedious.

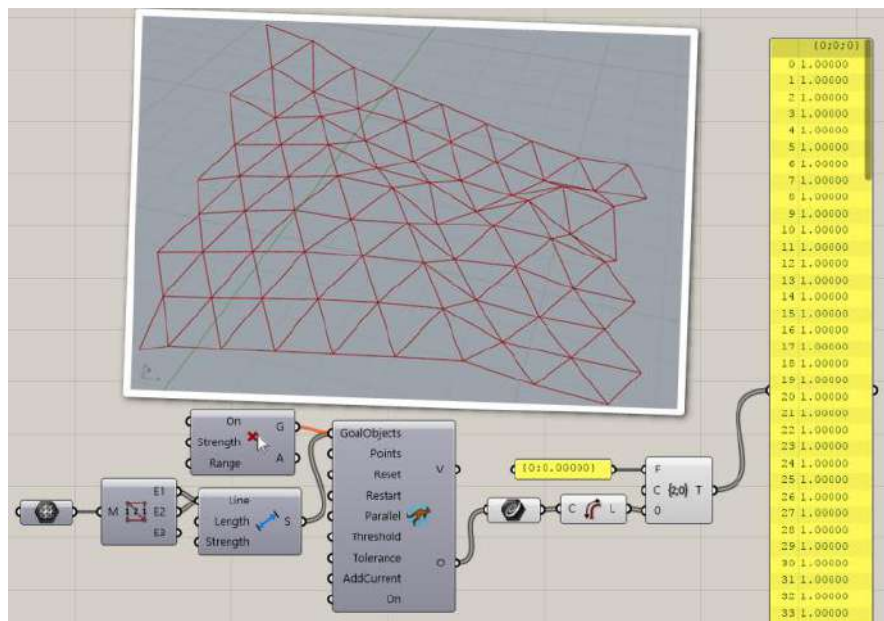


Figure 3.1 : Developing equilateral triangle mesh of doubly curved surface using kangaroo (physics engine) in grasshopper

The method that is explored in this research paper is to derive planar equilateral triangle mesh by using geometry-based mathematical methodology. The process consists of three parts recurring in a loop namely :

1. Logic-building
2. Analyzing the output
3. Problem solving

If in any case the logic fails, the loop will restart. The development of the triangle mesh is done by using basic components in grasshopper without any help of external plugins.

3.1 Exploration – 1 : By using orient component

In this script, an equilateral triangle is created with the help of polygon component. Then it is oriented on the surface by evaluating surface points.

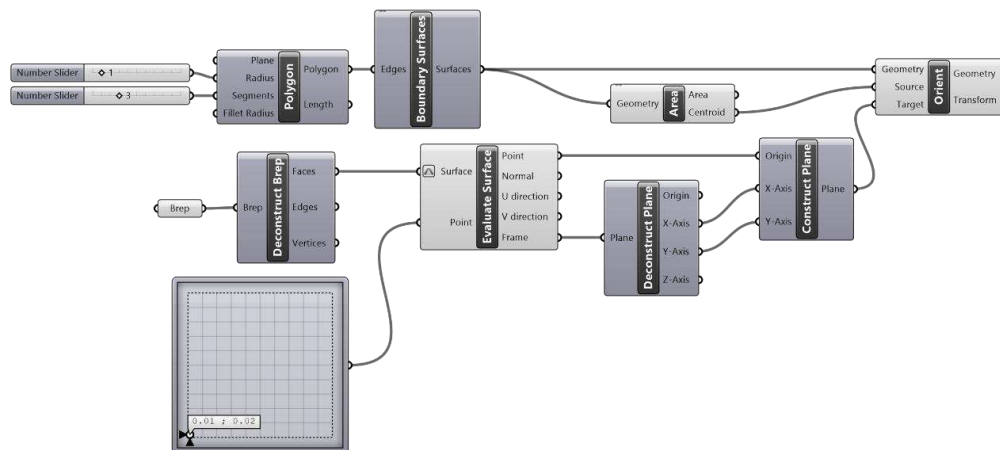


Figure 3.2 : Grasshopper script of exploration 1

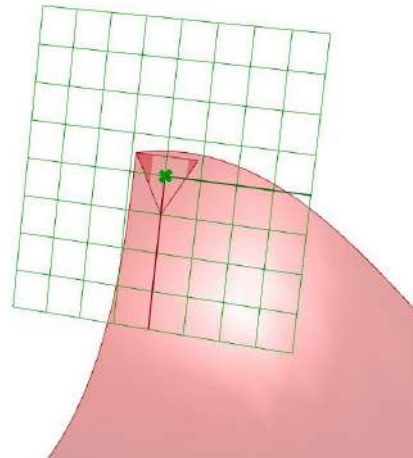


Figure 3.3 : Triangle oriented on the surface using script of exploration 1

Logic-Building	Analyzing the Output	Problem Solving
Using orient component-orienting a planar equilateral triangle to the points of doubly curved surface.	Only one triangle is oriented to the surface point.	Looping the script for multiple triangles.

Table 3.1 : Analysis of exploration 1

3.1.1 Adding Anemone component

Anemone component is added in the previous script to generate a loop of triangles arranged in a linear way on the surface. For creating it in a linear pattern, each triangle is rotated and aligned on the doubly curved surface using the orient component of grasshopper. The orient component helps to place each triangle adjacent to each other using vertices as a reference for orienting.

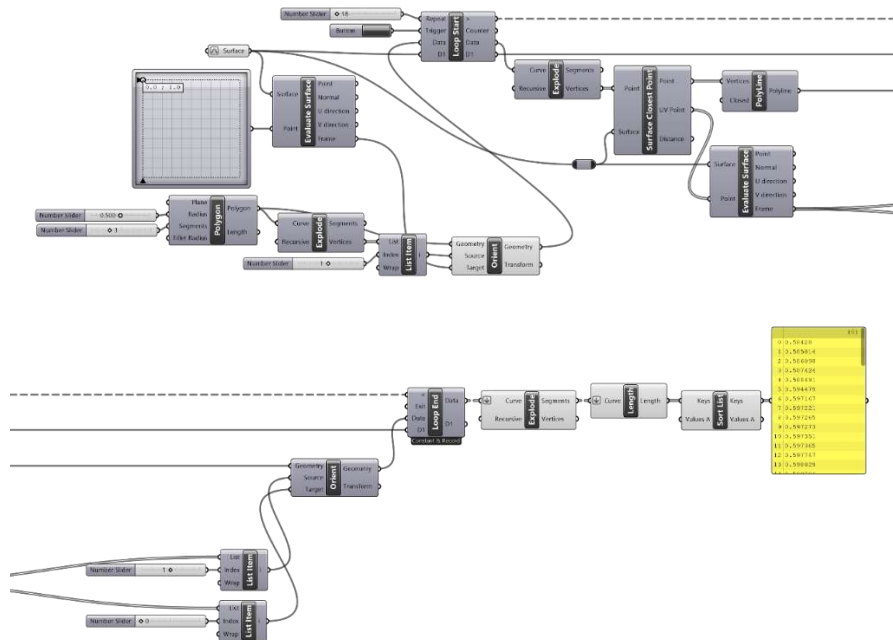


Figure 3.4 : Addition of anemone (loop) in the script of exploration 1

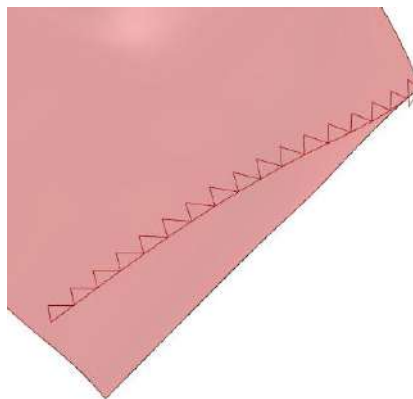


Figure 3.5 : Triangle oriented on the surface linearly

Though it visually looks like this script works well on the doubly curved surface, it fails to do so when the degree of the curve/surface changes drastically. The reason for this to take place is that the orient component only works by taking a plane of only one of the vertices of the triangle into consideration. Thus, the newly oriented triangle may or may not be aligned on the surface creating a floating vertex. It creates a loop of floating triangles which results in failure of the logic.

Logic-Building	Analyzing the Output	Problem Solving
Adding anemone component to the previous script to create a loop.	The vertices of the triangles derived are not connected to the surface points, therefore creating a gap between the vertices of each triangle.	Logic Failed. Build a new logic.

Table 3.2 : Analysis of exploration 1 modified

3.2 Exploration – 2 : Developing hexagonal grid by using sphere

In this script, initially a sphere is developed using a random point on the surface. It is then intersected with the surface to create a circle. The circle is then divided into six equal parts to create a hexagon. This hexagon is then converted into triangles by connecting the vertices to the centre of hexagon. For creating it in a linear pattern, a new hexagon is generated using any one of the vertex of the original hexagon as the centre. This is then converted into a loop.

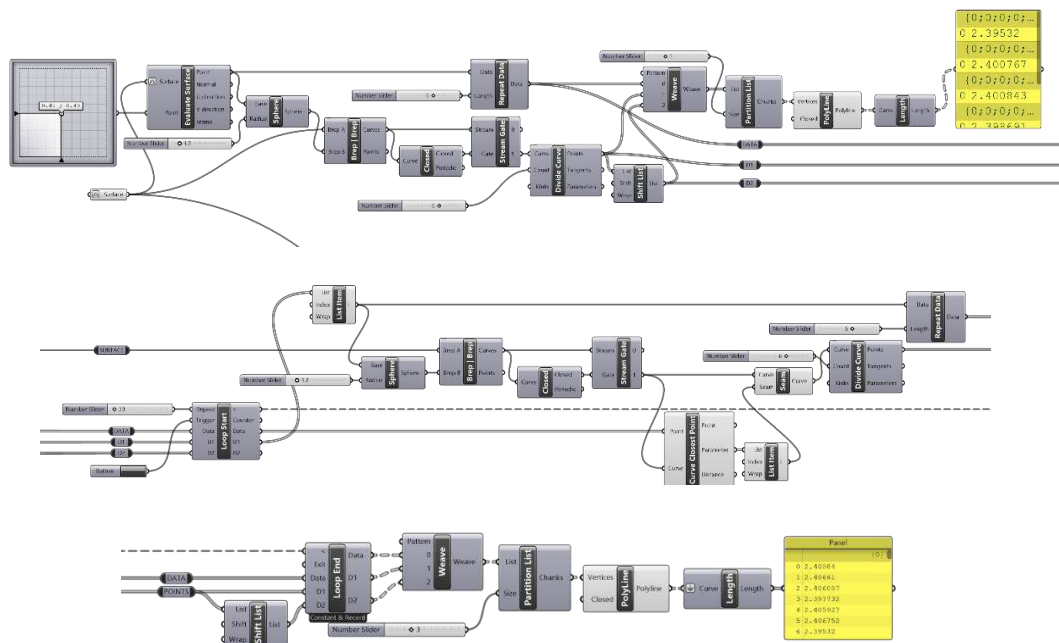


Figure 3.6 : Grasshopper script of exploration 2

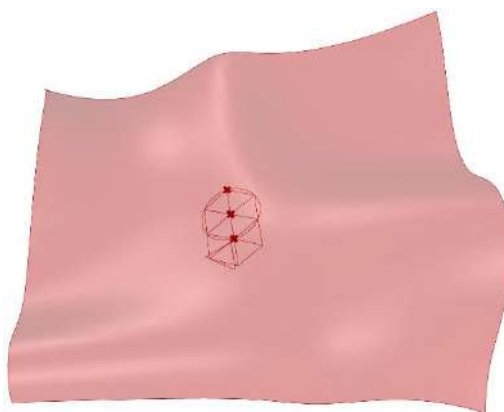


Figure 3.7 : Triangles created in the surface using script of exploration 2

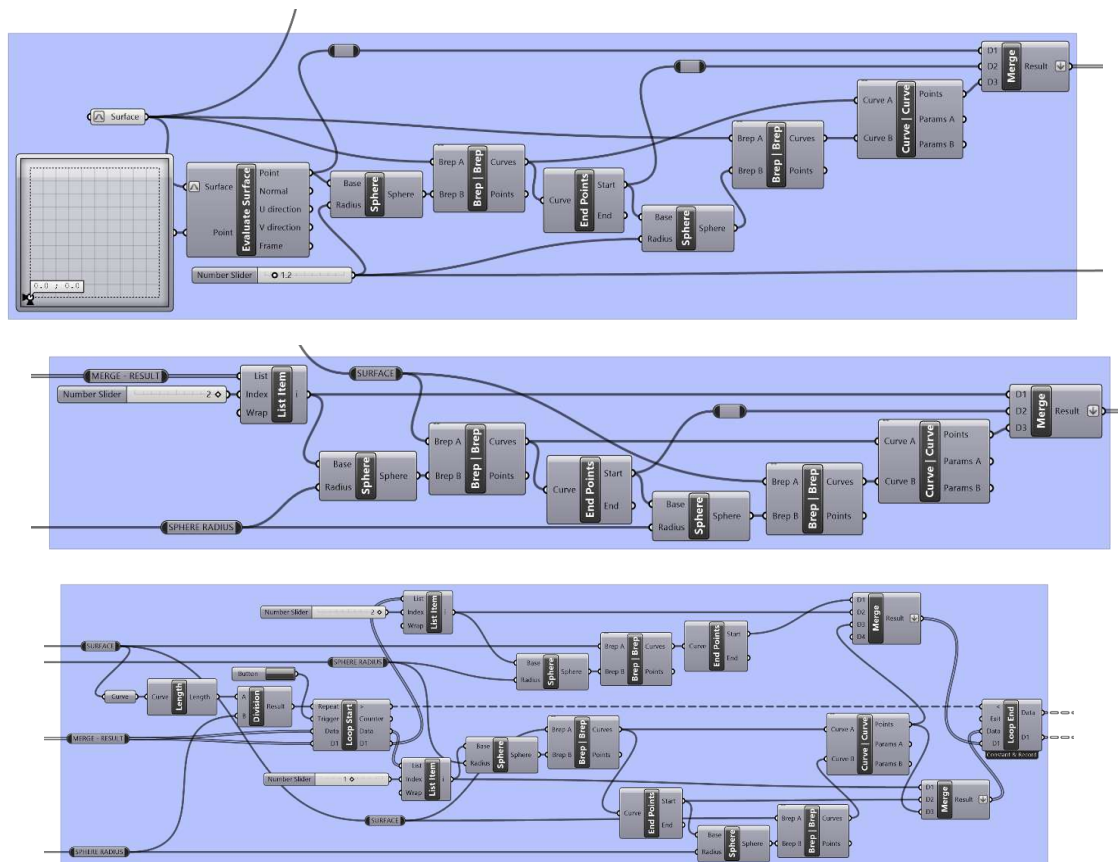
This loop fails when the origin point of the subdivisions of the circle gets shifted according to the world co-ordinates of the rhino software which ultimately gives a rotated hexagon as the output, thus failing the initial logic.

Logic-Building	Analyzing the Output	Problem Solving
Creating the equilateral triangle by using sphere.	Rotated hexagons are formed shifted according to the world co-ordinates	Logic Failed. Build a new logic.

Table 3.3 : Analysis of exploration 2

3.3 Exploration – 3 : Sphere intersection starting from surface edges

In this script, using one of the vertex of the surface, which will act as the first vertex of the triangle, a sphere is developed of a specified radius. The sphere is then intersected with the surface to develop a curve. The generated curve and adjacent edge of the original surface are intersected to develop a point which acts as the second vertex of the triangle. A sphere of equal radius to the first sphere is to be constructed on the second vertex. This sphere is then intersected with the surface to develop a new curve on the surface. The first curve is intersected with the new curve to generate a point on the surface which will act as the third vertex of the triangle. All the three vertices are now connected together to form a triangle. The above steps are then repeated to develop triangles on the periphery of the surface.



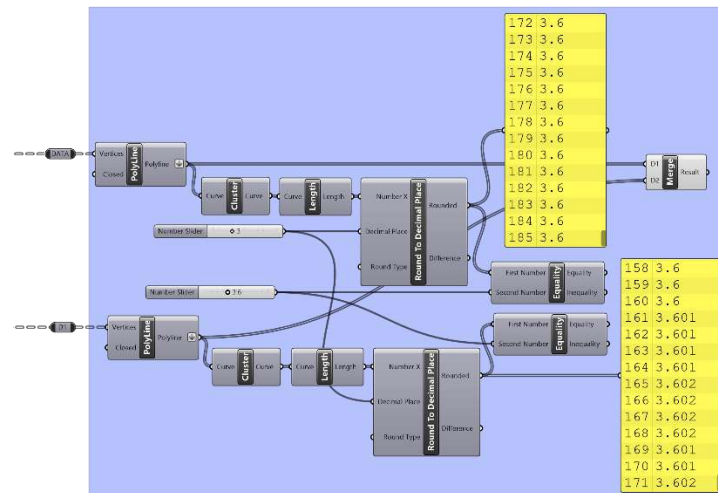


Figure 3.8 : Grasshopper script of exploration 3

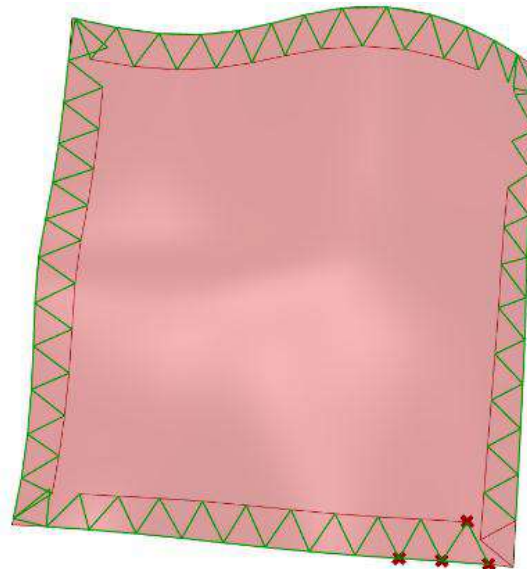


Figure 3.9 : Triangle mesh created on the periphery of the surface using script of exploration 3

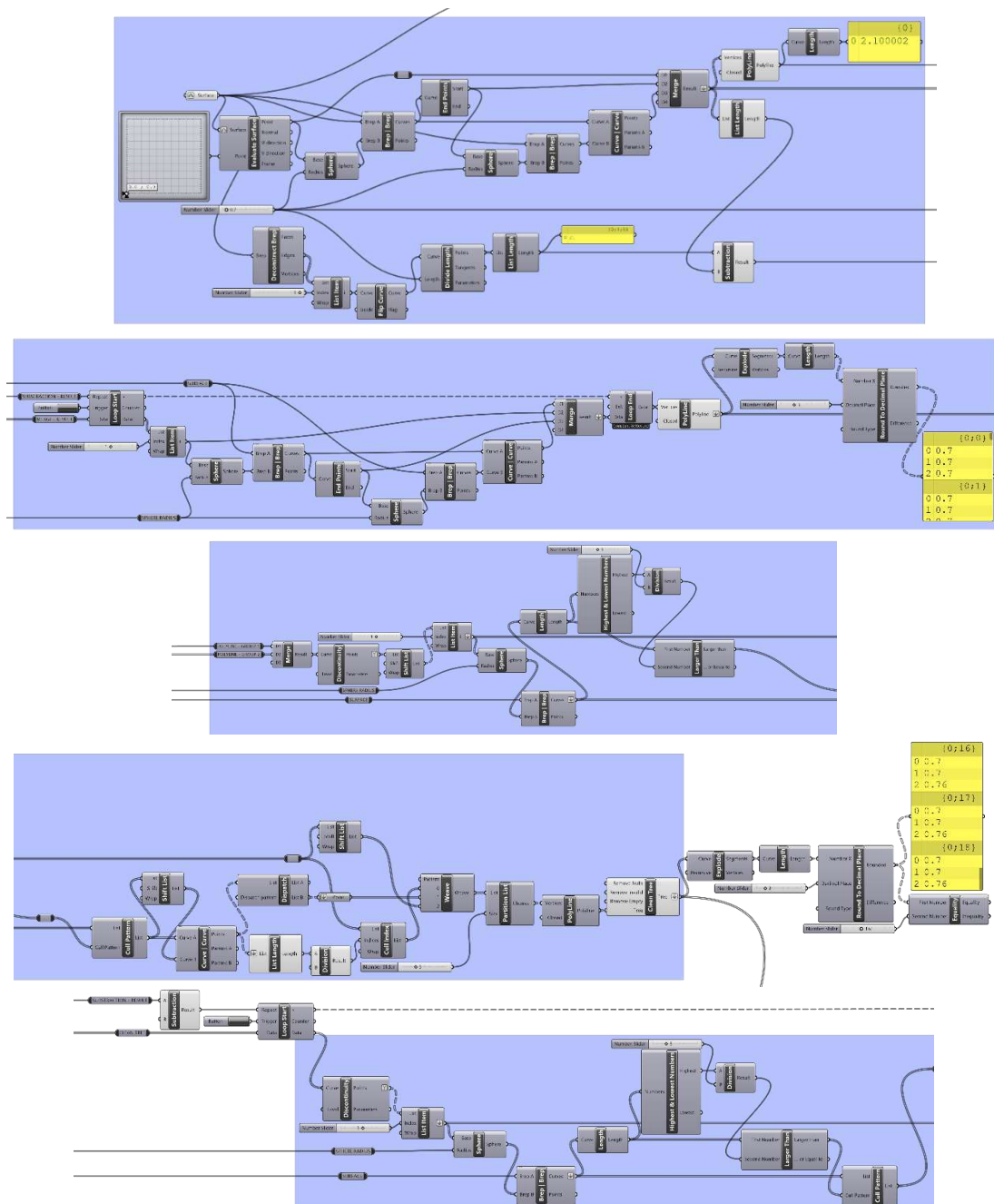
There are two points of failure in the script. The triangles created at the corners of the doubly curved surface are overlapping and may or may not be equilateral. This logic also fails because the edge of the surface is used as a reference to develop the triangles so it only works on the periphery of the doubly curved surface. Also it does not work in the central area of the surface which is away from the surface edge.

Logic-Building	Analyzing the Output	Problem Solving
Creating the equilateral triangle by using sphere.	Triangles are overlapping at the corners of the surface	Optimize the script.

Table 3.4 : Analysis of exploration 3

3.4 Exploration – 4 : By using sphere intersection

The first triangle is generated as described in Exploration – 3. The same process of developing the first triangle is repeated in a loop to develop a linear array of triangles on the surface. In the next step, the third vertices of all the triangles are used to construct new spheres that are intersected with the surface to develop new curves. These curves are self-intersected to generate new intersection points which will act as vertices for the new row of triangles. All the points now are segregated in groups of three points to construct equilateral triangles in the new row. The whole process is then looped to develop a grid of equilateral triangles.



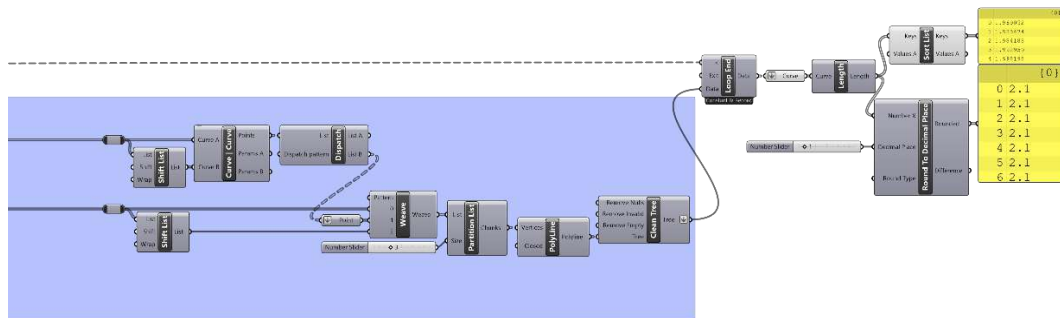


Figure 3.10 : Grasshopper script of exploration 4

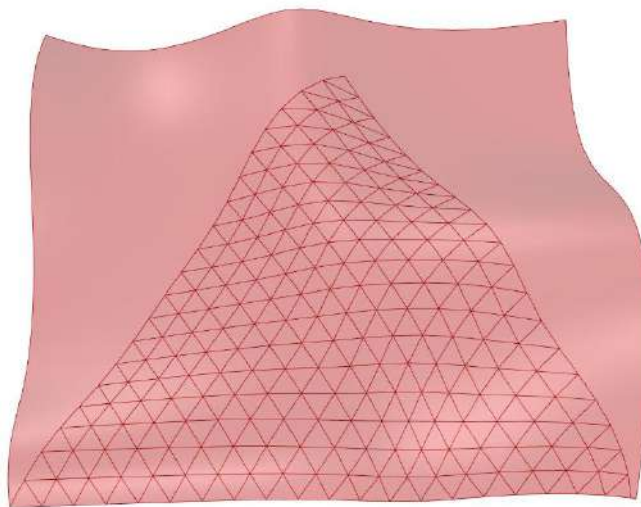


Figure 3.11 : Triangle grid created on the surface using script of exploration 4

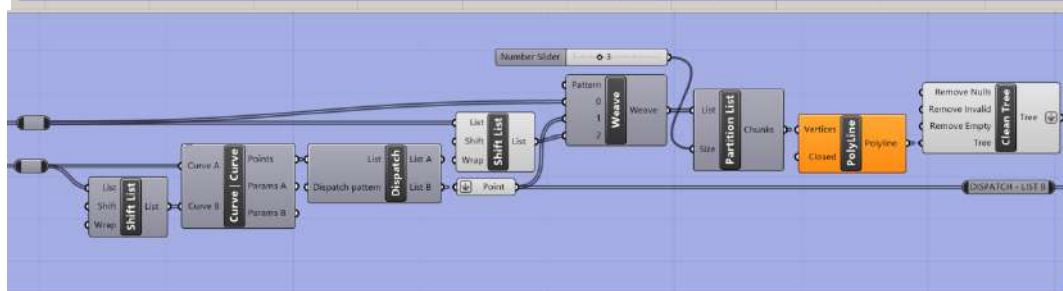
This exploration fails as one triangle from start and end point of the row is skipped generating a visual triangular grid and it terminates the loop.

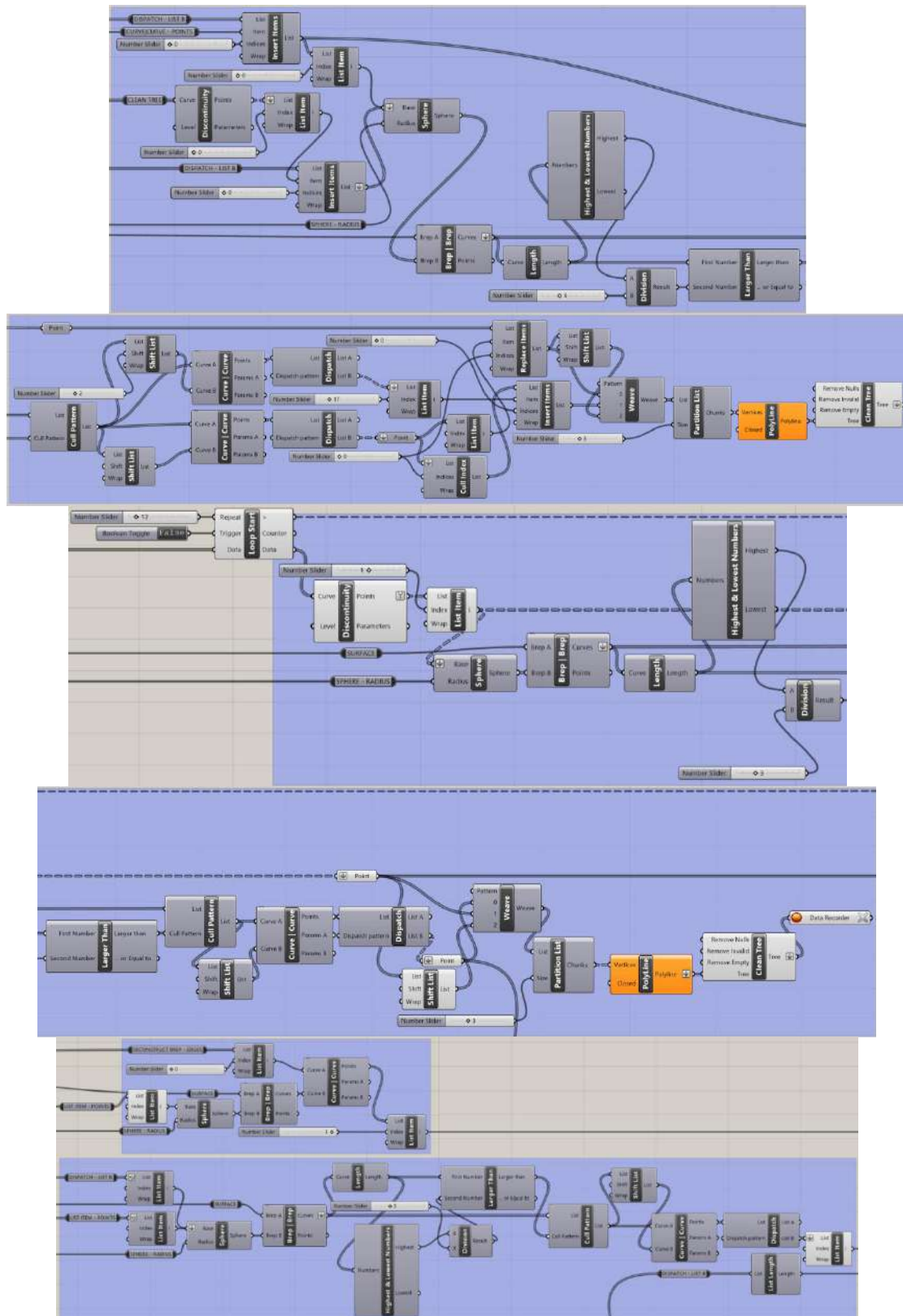
Logic-Building	Analyzing the Output	Problem Solving
Creating the equilateral triangle by using sphere.	Triangle from start and end point of the row is skipped generating a visual triangular grid and it terminates the loop.	Optimize the script.

Table 3.5 : Analysis of exploration 4

3.5 Exploration – 5 : By using sphere intersection (optimized solution)

The initial process of creating the first row of triangles on the surface is exactly the same as described in Exploration – 4. The script is optimized by reworking on the start and end triangles of each row such that the script does not terminate itself in a visual triangular grid and continues throughout the surface.





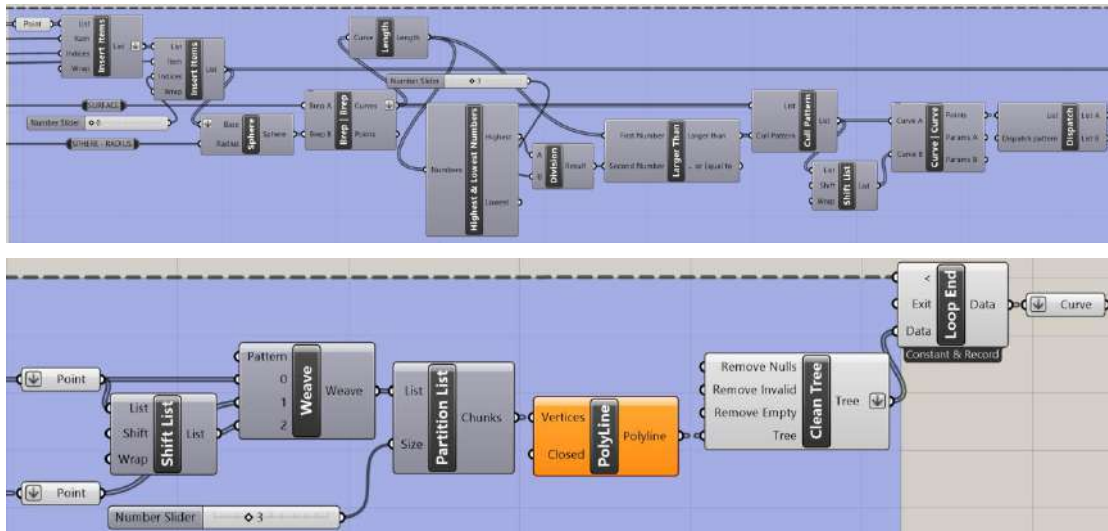


Figure 3.12 : Grasshopper script of exploration 5

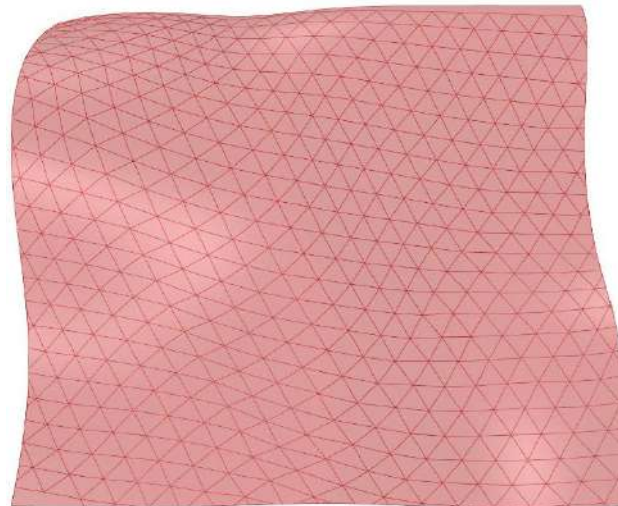


Figure 3.13 : Triangle grid created on the surface using script of exploration 5

Logic-Building	Analyzing the Output	Problem Solving
Creating the equilateral triangle by using sphere.	Triangles are formed on the surface	Problem solved

Table 3.6 : Analysis of exploration 5

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LAYOUT PLANNING OF INSTITUTIONAL BUILDINGS ON CONTOURED SITES: A COMPARITIVE ASSESSMENT

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Abstract: - This research paper is all about campus planning on contoured sites. There are different problems on different contours, the complexity depends on the slope angles edges on the site. Campus planning is all about connectivity between the academics and the social life. The landscape within the site enhances the inter-climatic conditions. The paper introduces the importance on campus planning on contoured sites. It studies the different campus to understand the nature of slope. The two different campuses consist of: i) Vidya Pratishthan's Campus, Baramati and ii) Sinhgad Institutes, Vadgaon Budruk. Both the campuses differ in terms of response to the contoured sites with the parameters such as: context, functionality, pattern of growth, landscape, form and building orientation. All the parameters are divided in two different sections: i) Overall site layout and ii) Individual building. The research paper gives overall analysis of how the campus is been designed with respect to original nature of site and developed site.

Keywords: - Contours/slopes, institutional building, campus, landscape, pedestrian, etc.

Introduction :- Campus planning identifies the long-term course for the built environment of a higher education institution. It guarantees the highest and best use of land to fulfil the academic, research, and outreach purposes of a college or university. Sloping sites, as opposed to level construction sites, generally indicate that the ground you wish to construct on is on an inclination or drop (or even slope sideways). The elevation of the block will be uneven. This often entails a rise or dip of three metres or less throughout the building area. The sloping sites or site adjacent to slope may affect access to the sun and views. For example, a west side facing hillside will have reduced morning direct sunlight and more direct sunlight in the evening, particularly in summer.

Relevance of the topic: - Campus always provides students a safe environment to study, live a social life, etc. It ensures the highest and best use of the space to meet academic outreach. Due to urban sprawl, people start migrating and thus it led to development in the mountainous region. Thus, it is important to understand the construction in hilly areas, which may make ease in encountering the complexity in construction. It is a high need to make students interact with nature and campus planning on hilly area may lead to it. Thus, it is needed to study the campus planning on contoured/sloping sites.

Background and Context: - India being independent 76 years ago, still is lagging from universal literacy level. The basic need of infrastructure is not being required in the number of campuses in India, though there are number of institutes in the country. Still there are many well known institutes in India which provide best infrastructure with the learning environment by the development according to the need or requirement to maintain a standard.

The Vidya Pratishthan campus is one of the well-known institutes in Baramati which provide education from high schools to senior colleges. Being, the private college affiliated by Savitribai Phule Pune University, the institute is known country wide. The Vidya Pratishthan's campus Baramati is a renowned campus from last 50 years. Sinhgad campus one of the well-known institutes in Pune as we all know Pune being an educational hub in the system of high schools to higher educations, thus the institute provides with greater infrastructure and learning environment with the enhancement of the nature. The Sinhgad institute is well known for past 25 years.

1. Location map of Sinhgad Campus

(Source: - Google and Google Earth)

- Spaces: - Institutional buildings, playgrounds, landscaping elements, accessibility.

- Management of contour/sloping lands within campus planning.
- Neighbourhood: - Residential areas, agricultural lands, community centres, etc.

Baramati is a city and a municipal council in the Pune district in the state of Maharashtra, India. It is famous for its famous sugarcane plantations. Pune, it is a metropolitan city with one of the best industrial and educational hub, it is also famous for its beauty of nature of the earth.

Literature Review: -

The book titled Campus Design in India – Experience of a developing nations is written by Ar. Achyut Kanvinde and Prof. H. James Miller. Section A, Chapter No.02 “University Campus- Place of Fulfilment” describes that a university campus can be compared to a **small-scale city** which is a unit of education. It can also be defined as a cluster of same patterns. It should be comfortable, safe, and approachable. The **context of the campus** should be mattered as it should disconnect the disturbance from the concentrated students, i.e., the campus should be at the outskirts. Design should be done w.r.t **community, culture, and context**. The paper titled A Study of Planning, Design and Construction of Buildings in Hilly Regions of India is written by Prof. Vrushi Chawhan and Prof. Mohammad Arif Kamal. It is published in Issue no.1, Volume no.9 February 03, 2021, American Journal of Civil Engineering and Architecture. The following research paper deals with the study of designing buildings on hilly regions of India. The architecture on contoured/hilly area is beautiful but it is that times of complex to build. The research methodology for this research paper is Qualitative research methodology. The research paper is divided into two parts the one is prior investigation of the site, learning the **topographical data of the site**, the climatic data, the site reconnaissance, and the site investigations. While, the other part comprises of the layout explanation, **the design strategies to encounter the critical areas**, and how the contour works while constructing and the context of building. The paper titled Design Process of a Campus Plan: A Case Study of Duzce University Konuralp Campus is written by Prof. Ozgur Yerli and Prof. Fang Tan. It is published in Issue no. 04, Volume no.07 April 2017, Int. Journal of Engineering Research and Application. In the following research paper while describing the term campus the writer highlights the three major aspects which should be considered in campus design, i.e., **accessibility, safety, and social engagement**. Nowadays, the campus is the way towards development, thus it should be done sustainably. In this research paper it is described as Konuralp campus design, while the research question of this paper is, The educational building were separated and were distant from the social buildings such as **sports centre, cultural centre** by using pedestrian walkways. The **core** of the campus does consist of student **centre, amphitheatre, ceremony area, library**, etc. and thus the campus was designed using **sustainable and accessible concepts**. The paper titled Campus Planning is written by Prof. Snehal Damugade, Prof. Yuvraj Damugade and Prof. Tejas Pingale. It is published in Issue no. 01, Volume no.10 ,2017, International Journal of Engineering Research and Technology. The aim of the research paper is campus planning by using different design **principles to increase the aesthetical and functional** value of the design. The paper describes the purpose of campus design. Within the heading Guidelines there are number of sub-heading which describes the **site layout, pedestrian and public spaces, gateways and entrances, way finding/signage, landscape, context, major spaces, landscape elements, proper orientation**. The paper concludes with, the campus planning should be done considering urban planning and collecting the key points such as **vista, skyline, viewpoints, path, edges, and landmark**, etc. With the help of design principle, the pleasant campus can be designed. Campus design assures comprehensive growth and integration of design aesthetics, functionality and **flexibility, and the sustainability** of design.

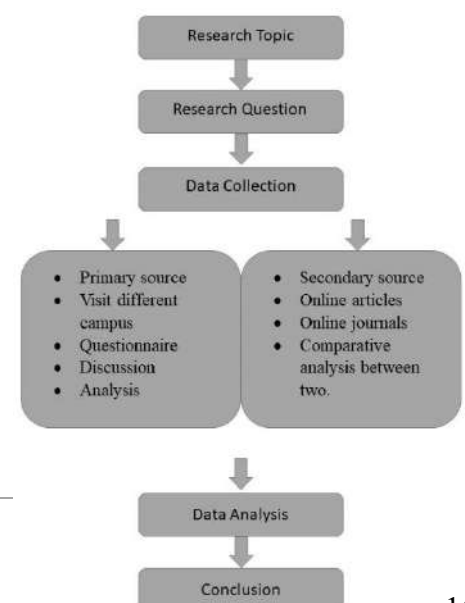
Research Question: -

- How does the campus planning differ on different contoured sites?
- Does construction on sloping sites develop dead spaces?
- Does landscape in campus planning impacts climatic condition in the campus?
- Does pedestrian route on contoured sites enhance the circulation throughout the campus?

Aim: - To generate a template for understanding and assessing campus planning on a

sloping site.

Objectives: -



1. To understand the contoured open spaces.
2. To understand the concept of playgrounds on contours.
3. To understand the concept of landscape design in contours.
4. To study the designs developed at sloping sites.
5. To study the bye laws of hill architecture.
6. To understand overall campus planning on sloping site.

Scope: -

1. The scope is to consider design which includes bye laws of hillside architecture.
2. The process of developing playgrounds on sloping site.
3. The process of handling the proper circulation on roadways a sloping site.
4. To understand how design varies according to slopes.

Limitations: -

The data is limited to two campuses one in Baramati, and another in Sinhgad, Pune; thus, the solution it includes will differ with different contour slopes.

The comparative analysis through template only between two campus designs.

Research Methodology: - To visit, document, reports, observe, sketch-out, develop sections, architectural analysis.

Parameters for Analysis: -

- Researcher's observations on sloping sites of two different live case study.

Campus Study of two different sites will include:

Overall planning of the sites: -

- Overall site
1. Context
 - Site surroundings
 2. Pattern of Growth
 - Linear -overall layout
 - Radial
 - Molecular
 - Zonal
 3. Scale
 4. Landscape design on the site.
 - Greenspaces
 - Multiple use of open spaces
 5. Road planning strategies on the sites
 6. Circulation patterns
 7. Pedestrian ways, vehicular access
 8. Drainage services
 - Water outlet
 - Individual Building

1. Form

- Building orientation and location on the sites.

According to Ar. Achyut Kanvinde's discussion in "Campus Design in India – Experience of a developing nations" Section A, Chapter No.02 "University Campus- Place of Fulfilment" following are the considerations of design:

1. Context - The context regarding the site is must as the form or the style to design through totally depends on the conceptual aspects.
2. Growth of campus – The derivation of the campus is from a single unit which later expands into a pattern as per the requirement.
3. Pedestrian way – The walkways for easy access within the site must depend mostly upon.
4. Circulation pattern
5. Landscape
6. Social spaces
7. Water outlets for drainage.

These are used as parameters for analysis to evaluate campus plans of case studies

Case Study Analysis: -

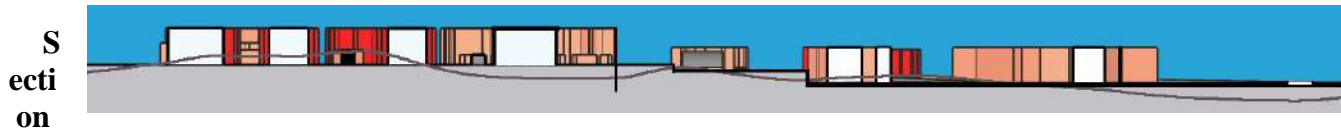
a) The first case is the campus of **Vidya Pratishthan** at Baramati.

Introduction:- The Vidya Pratishthan campus comprises of the institutional, residential and commercial buildings. The campus is being developed on a contour site which have a slope of around 12m – 15m. The most common factors which took place in the campus was proper zoning of the area with proper circulation pattern. The challenges for the architect for designing the campus are mostly the road patterns, the drainage layout, the



use of the contour, the sports arena, recreational spaces, different types of buildings, etc. within a single campus. The type of soil in Baramati is black soil which has a characteristic of fertility and is good for the purpose of cultivation of crops, thus the soil holds the more amount of water in it and it would be a challenge for the architect to design the foundation according to it with more stability and the strength within it for greater lifespan of the structure.

Sections: -



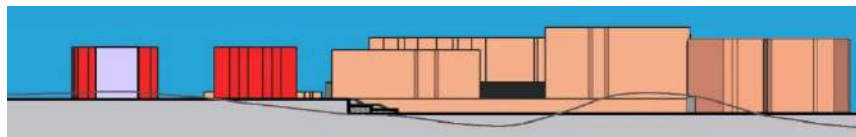
AA'

The above section describes the cut and fill method used for development of campus and managing the contours. The slope tends towards the municipal corporation proposed drainage line.



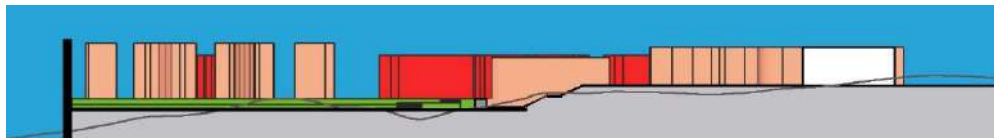
Section BB'

The above throughout section shows the management of contours throughout the site, the road derived at the centre divides the site in two parts for ease of access within the site and managing the contours with water outlets towards the municipal corporation proposed drainage line.



Section KK'

The above section defines the composition of ground by cut and fill method.



Section JJ'



Parameters

■ Overall site

1. Context: - Layouts responding to contextual situations.

- **Observation:** - The campus is differentiated in two parts Upper campus and Lower campus. The road between the lower and upper campus divides the campus in two parts. The road is the property of the campus, but it was derived for the purpose of easy access within the site. Both the campuses can be entered from different entrances through the outskirts of the site thus, greater independence. Several outskirts' areas have been connected to each other due to development of the campus and addition of roads between the campus.
- **Response to the sloping site:** - The entries from various outskirts of the city has been connected due to the development of the campus.

2. Functionality: - Functions of the contours and spaces created.

- **Observation:** - The contours management led to drainage of rainwater through roadside drain so that it doesn't enter in the lower campus to ruin the entry ambience.
- **Response to the sloping site:** - The overall site is a contoured site. The upper campus is 4-5m higher than the lower one.

3. Pattern of Growth: - Rate of growth in the campus.

- **Observation:** - The site is developed, or the growth of the campus is in zonal pattern. The institutional and administrative were developed first, then as per the growth of the institution there were need of commercial

and residential buildings. Thus, growing pattern is totally depending on the needs and wants as per the growth of institutions.

- **Response to the sloping site:** - The development of land is done as per the requirements. The institution on upper campus was the very first development done in the site. After the growth of the institution for Jr. College, there was requirement of the higher educational institutional thus as per the needs the growth was depended which went on from higher slope to lower slope.

4. **Landscape:** - Addition of landscaping elements to work with the flow of contours.

■ Playgrounds

○ **Observation:** -

- At the Upper Campus, the playground is placed at the least altitude.
- The playground at the upper campus is surrounded by seating steps from two sides for viewers.
- The playground here is surrounded by the dense trees on the seating steps, creating a pattern along the boundary of the ground.
- At the Lower campus, the ground is placed to the centre forming radial planning at the lower campus.
- The ground is visually connected through the main entrance of the lower campus.
- It creates the social engagement as it is surrounded with seating steps all around.

- **Response to the sloping site:** -At upper campus, the whole plateau of the playground is dig into a plain land and the cut part has been used for the other built ups causing zero waste and sustainability. At lower campus, the ground is developed with a gradual slope covered peripheral with stepped seating.

■ Individual Building

1. **Form:** - Formation of the building with response to site.

❖ **Gymnasium**

○ **Observation:** -

- Symmetric
- Plaza in between the buildings acts as
- Social engagement
- Physical connection
- Visual connection
- Wind channel from west to east.

○ **Response to the sloping site:** -

Plaza Gradually descends to ground creating landscaped multifunctional court. The plaza is developed upon a created plateau for the purpose of visual connectivity .

❖ **Vidya Pratishthan's Arts, Science and Commerce College**

○ **Observation:** -

- The main plaza in the site as centred in the entrance.
- Symmetrical in form.
- Physical connection with the site.
- The plaza is placed at the highest altitude of the site.

- The plaza creates the distribution of the site.

○ **Response to the sloping site:** -

- The plaza is on the highest altitude, thus causes no water logging as water flows downwards with the contours.
- The plaza is centred in the entrance and the path along creates the distribution of the site.

❖ **Vidya Pratishthan's Vasantrao Pawar Law College**

○ **Observation:** -

- Axially symmetrical in shape.
- No visual connection through the main entrance.
- The plaza is on the highest altitude along with the Jr. College.

○ **Response to the sloping site:** - The plaza

gradually descends downward creating a downward path alongside. As there is no visual connectivity through the main entrance, the plaza has the separate entrance which is along the main road creating a visual connectivity.

❖ **Vidya Pratishthan's Institute of Information and Technology.**

○ **Observation:** -

- The very first development on the lower campus.

- The building has quite height than other buildings developed in that era.
- Symmetrical form

- Visually connected through the outside of the site due to height of the plaza.
- The building is developed in the lower campus.
- **Response to the sloping site: -**
- ❖ **Vidya Pratishthan's Kamalnayan Bajaj's Institute of Engineering and Technology**
- **Observation: -**
 - Placed opposite to the 'Vidya Pratishthan's Institute of Information and Technology'
 - Symmetrical form
 - Visual connectivity through the central ground and canteen
- ❖ **Vidya Pratishthan's School of Biotechnology**
- **Observation: -**
 - The entrance of the plaza is visually connected through the context.
 - The slope from the entrance to the building is quite stiff.
- **Response to sloping site: -**
 - Due to stiff contours and vehicular roadway is provided from the entrance to cover the slope but to keep the pedestrian walkway in context the provided pedestrian way alongside the road is difficult for users to use.

❖ Vidya Pratishthan's School of Architecture

- **Observation: -**
 - The building has a huge courtyard making it a social interactive space.
 - It also has been developed on levels of two contours creating basement from front and ground level in back.
- **Response to the site: -** Two contours have been maintained and without disturbing the original nature of the slope the building has been developed. The lowest floor gets natural light ventilation due to the management and proper use of contours.
The open space is used for parking and the building shadow is greater due to more level differences.

2. Building Orientation: -

- Buildings should be aligned with respect to the contours such that it should get minimum direct heat such that it should get minimum direct heat by placing longer side N-S direction.
- Wind channels must be created.
- Space creation due to the management of contours.

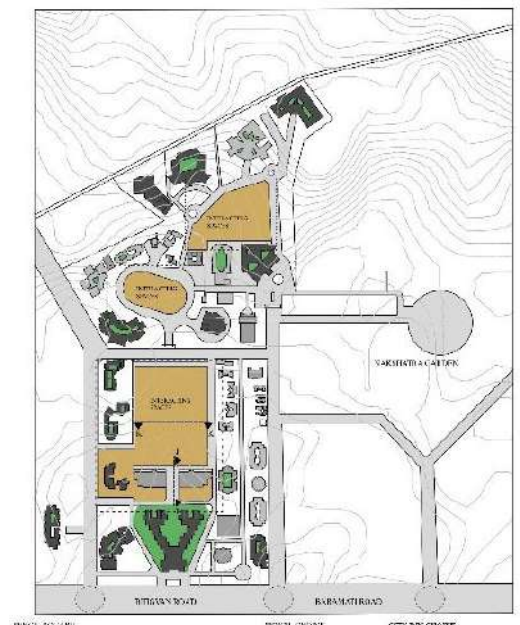
❖ Institutional Building

- **Observation: -** All the institutional building are placed facing towards north direction. All the buildings have courtyard within them for better indirect light. The courtyard acts as a social interacting space. All the buildings have green spaces in the front creating forecourt and keeping buildings away from the direct road contact.
- **Response to sloping site: -** All the institutional buildings have glass façade to the front facing as a result may absorb more heat and may lead to high temperature within the buildings. As all the institutional buildings have glass façade for aesthetics, but due to north facing it acquires more of indirect light and lesser heat.

❖ Residential (Staff- Quarters)

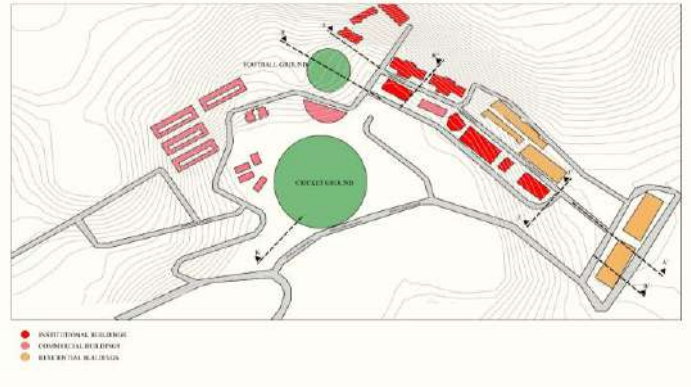
- **Observation: -** All the residential buildings are facing towards east.
- **Response to sloping site: -** All the residential buildings are facing towards east as considering of vastu and though the buildings have been facing east but due to dense vegetation it does not get direct sunlight.

❖ Residential (Hostels)

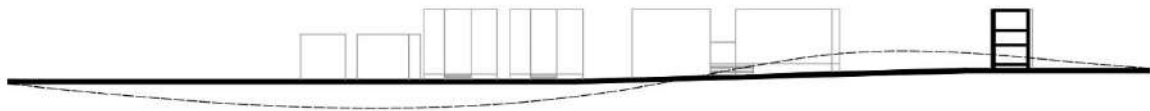


- **Observation:** - All the hostel buildings in lower campus are facing towards north. All the hostels which are in the upper campus are east facing.
 - **Response to sloping site:** - The hostel buildings in the lower campus are facing towards north as for visual contact from entrances and indirect lighting within for comfort living. The hostel building in the upper campus are facing to the east, but due to denser rate of landscaping and vegetation direct lighting of sun does not hit the building.
- b) The second case study is of **Sinhgad Campus, Vadgaon Budruk, Pune.**

Introduction: - The Sinhgad campus comprises of the institutional, residential and commercial buildings. The campus is being developed on a contour site which have a slope of around 25m-30m. The most common factors which took place in the campus was proper zoning of the area with proper circulation pattern. The challenges for the architect for designing the campus are mostly the road patterns, the drainage layout, the use of the contour, the sports arena, recreational spaces, different types of buildings, etc. within a single campus. The type of soil in Pune district is black soil which has a characteristic of fertility and is good for the purpose of cultivation of crops, thus the soil holds the more amount of water in it and it would be a challenge for the architect to design the foundation according to it with more stability and the strength within it for greater lifespan of the structure.

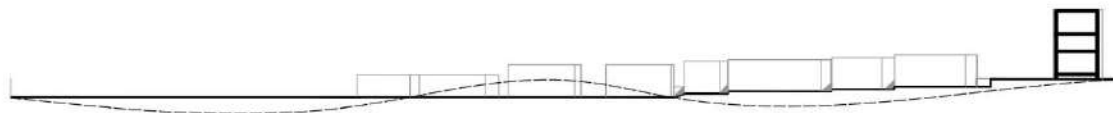


Site section: -



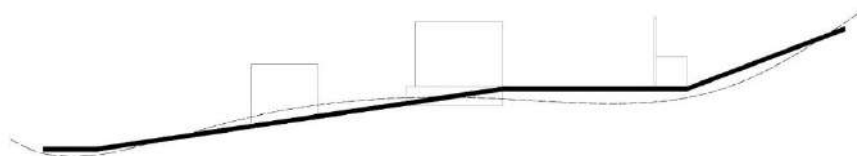
Section AA'

The above section shows the linear section cut down from road to understand the contours with a major slope of 3m. The dotted line in elevation is the contour height behind the building.



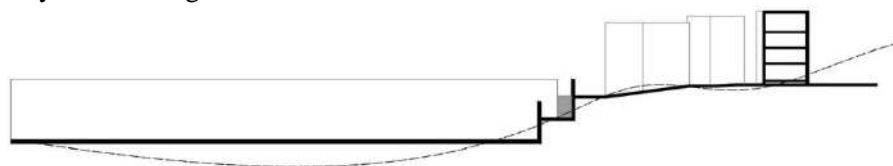
Section BB'

The above section describes the cut section of road which highlights the levels of the institutional buildings according to contour and levelled by managing cut fill method.



Section JJ'

The above sections describe how the platform is being created on contour by cut and fill method for the purpose of converting the plain land by zero wastage.



Section KK'

The above section describes the how the contours vary after a specific distance and how the spaces are given according to it.



Parameters

▪ Overall layout discussion

1. **Context:** - Layouts responding to contextual situations.
 - **Observation:** - The campus is totally developed on contours. The road tends their slopes towards the ground and the drainage lines of municipal corporation which leads to no water logging. The roads are directly connected with Sinhgad college roads with no breakages. The campus is surrounded with many commercial plazas leading to ease of getting needs and matches contextually. The campus does not have a proper boundary, but the high contour acts as the security for the campus.
 - **Response to the site:** - The site is totally contoured of 3m height leading to easy cut and fill method for a floor or more.
2. **Functionality:** - Functions of the contours and spaces created.
 - **Observation:** - The road patterns provided within the site are derived after the buildings were constructed.
 - **Response to the site:** - The steep slope leads to draining of water directly to the ground and not ruining it.
3. **Pattern of Growth:** -
 - **Observation:** - The pattern of growth is linear pattern the wholesome campus of Vadgaon Budruk was developed between the year of 1995-2001. The campus was wholesomely planned together and was developed within a span of 10 years / decade.
 - **Response to the site:** - The buildings were planned in linear pattern creating the slope that tends towards the drainage line and the grounds.
4. **Landscape:** - Addition of landscaping elements to work with the flow of contours.
 - **Observation:** -
 - There is no defined pattern of landscape in the campuses.
 - Only to cover the contour stairways is provided between two contours and buildings.
 - The plinth of the building is quite high to not reach the water table.
 - **Response to the site:** - The slope between two parallel roads is quite steep so to reach the other ways stairways have been provided. The playgrounds have been placed on plain land to maintain the steadiness in the ground. The cricket ground on the lowest contour and to the entrance side so as more the requirement from outsiders as well and ease of access while the football ground near the schools as a multipurpose area. Hard scape is very less except roadways. The stepped seatings for auditorium is provided which is open to sky to have connection with the nature.

▪ Individual Building

1. **Form:** - Formation of the building with response to site.
- ❖ **Sinhgad College of Architecture**
- **Observation:** -
 - Symmetrical form of the building.
 - The stairways connecting two roads between the buildings creates social engagement between the students of different branch.
 - The visual connection increases alongside the building.
 - **Response to the site:** - The SCOA is placed on the corner edge of two roads one of 6m wide and other of 9m wide road. The slope of roads created due to contours creates dead spaces, thus, to tackle that retaining walls have been placed and the platform is created to make use of the contours.
- ❖ **Sinhgad Spring Dale Public School, (CBSE Board) Vadgaon**
- **Observation:** -
 - The rectangular form of the building is divided in three different blocks.
 - The open space between the blocks gives use of more light ventilations.
 - The open space between is a social engagement space for children in response to more engagement.

- **Response to the site:** - The school has been developed on the plane lands so as to get ease in walking and playing areas for children. In response to children friendly designs no slopy land have been kept for schools. The football ground has been placing near the school as a requirement of plain land for the playground.
- ❖ **Sinhgad Dental College and Hospital, Vadgaon**
- **Observation:** -
 - Symmetrical form of the building.
 - The college has been placed in the lower height area.
 - The visual connection increases alongside the building as it has direct vision of cricket ground.
- **Response to the site:** - The slope of roads created due to contours creates dead spaces, thus, to tackle that retaining walls have been placed and the platform is created to make use of the contours.
- ❖ **Sinhgad College of Engineering, Vadgaon**
- **Observation:** -
 - Symmetrical form of the building.
 - The stairways connecting two roads between the buildings creates social engagement between the students of different branch.
 - The visual connection increases alongside the building.
- **Response to the site:** - The slope of roads created due to contours creates dead spaces, thus, to tackle that retaining walls have been placed and the platform is created to make use of the contours.
- ❖ **Sinhgad College of Pharmacy, Vadgaon**
- **Observation:** -
 - Symmetrical form of the building.
 - The stairways connecting two roads between the buildings creates social engagement between the students of different branch.
 - The visual connection increases alongside the building.
- **Response to the site:** - The slope of roads created due to contours creates dead spaces, thus, to tackle that retaining walls have been placed and the platform is created to make use of the contours.
- ❖ **Sinhgad Institute of Management, Vadgaon**
- **Observation:** -
 - Symmetrical form of the building.
 - The stairways connecting two roads between the buildings creates social engagement between the students of different branch.
 - The visual connection increases alongside the building.
- **Response to the site:** - The slope of roads created due to contours creates dead spaces, thus, to tackle that retaining walls have been placed and the platform is created to make use of the contours.
- 2. **Building Orientation:** -
 - Buildings should be aligned with respect to the contours such that it should get minimum direct heat by placing longer side N-S direction.
 - Wind channels must be created.
 - Space creation due to the management of contours.
- ❖ **Institutional Building**
- **Observation:** - All the institutional building are placed facing towards west direction.
- **Response to sloping site:** - The west facing buildings are covered with dense trees which protect from harsh sunlight and the slope and the closely placed buildings creates buffer between results in cool breezes formation.
- ❖ **Residential (Staff- Quarters)**
- **Observation:** - All the residential buildings are facing towards north.
- **Response to sloping site:** - All the residential buildings are facing towards north causing comfort living for the staffs
- ❖ **Residential (Hostels)**

- **Observation:** - All the hostel buildings in campus are facing north
- **Response to sloping site:** - The comfort living is the major task in residential spaces thus north facing relates to it for indirect sunlight. And the placement of the blocks is on the plane lands for ease of access.

Analysis: -

Parameters	Vidya Pratishthan Campus	Sinhgad Campus
Context	The campus is bounded to its outskirts which results in greater independence, but it breaks the connection with the outside context. Due to the development of the site, the connection of outskirts regions has connected to the city.	There is no proper boundary to the campus but the contours act as the barrier for security purpose. Moreover, lesser boundaries created direct connection with the locals as well.
Functionality	The management of the contours is done such that the drain water flows with the contours without ruining the ambience of the entrance of the campus.	There are no proper drain channels provided within but the water flows through the roadways and gets collected in the pit at lower contour causing foul smell and disturbing the ambience of the entrance.
Growth Pattern	The zonal growth pattern was the result of growth in the need of education with the changing eras.	The linear pattern was designed together, and everything was setup in the span of 10 years.
Landscape	The grounds were developed by using cut fill methods of contours. The greater contours resulted in two parts of the campus. The connection of the both the parts of the campus is lesser due to division of campus. The landscape was encompassing in the contours to not to destroy the nature of land and enhancing it more and creating social engagement places. Both the grounds have stepped seating's around creating social engagement areas with visual connectivity around.	No defined pattern of landscape is provided. Only the stairways between two buildings which connects two higher contour is a space of social engagement.
Building Orientation	All the residential buildings are north facing. The staff quarters are east facing. While the institutional buildings are north facing resulting in comfort and indirect sunlight.	All the residential buildings are north facing. The institutional buildings are west facing but the dense trees act as a barrier for harsh sunlight.
Form	The forms of the building according to the context is symmetrical.	The forms of the building according to the context is symmetrical.
Road Patterns	Defined vehicular road patterns with pedestrian walkways around.	Uneven vehicular road patterns with no defined pedestrian road pattern.

Both the campuses differ from each other from its origin to its final stage with the nature of their sites. The VP campus in terms of the road pattern, the roads developed within the site not only divides the site in two different parts but also it works as a path of connection with the outskirts areas of the town. When it comes to Sinhgad there is no proper road pattern provided due to higher slopes. Considering the landscape design of the campus the VP campus has used the contours as spaces of recreational which creates social engagements in much clearer way and same goes for the Sinhgad institutes as well in terms of landscaping.

Most of the buildings constructed in VP campus are created by developing flat lands on contours by cut and fill methods while some of the buildings have been constructed with the proper use of the original nature of the site. The buildings in the Sinhgad campus are constructed by using the original nature of the contours. Both the campuses have developed a better solution for drainages with the slopes of the contour thus causing no water pits and greater ambience.

Conclusion: -

- i. Campus planning not only depends upon the requirement of users but also it should be done with the parameters in overall layouts and individual buildings such as context, functionality, pattern of growth, landscaping, building orientation, form, etc.
- ii. Both the campuses designs differ as per the requirements of the users.
- iii. Not every contoured site can be used in same manner as other because of the uniqueness of the site the dependency on the context, the functionality according to availability of resources, etc.
- iv. The use of the contour can be done without reincarnating it.
- v. The method of use of contour is better in terms than cut and fill method as the need of not to disturb the natural nature of the site.
- vi. The research paper concludes with the fact that campus planning is a whole and sole relation between the user and the site.

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Assessment of Imageability of the contemporary fringes in the context of Pune city.

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Abstract :

The urban society today is undergoing transformation from an agrarian society to industrialization and then to postindustrial society. Change in the socio economic aspect of the fringe areas of the Pune city has resulted into the shift in the occupational pattern due to the emergence of postindustrial economy. Due to the uncontrolled development, the adjoining rural areas are being constantly acquiring urban character. These urban influences change their outlook, way of living in turn transforming the area completely which has led to the loss of the identity of the area. The haphazard developments and the piece meal kind of a development have led to fragmentation of fabric, safety and security issues. New development follows the norms and policies as recommended for the city. Such consequences lead to ignoring the context and immediate surroundings of the area. These newer developments though have made an attempt to create new experience; it is limited to the gated enclaves. These changes in land use and stress on resources need to be addressed for an integrated development.

This research is based on the assessment of imageability of the fringe areas of the Pune city. Through understanding the character of fringe area and studying the theories based on imageability, the parameters are derived, which contribute to the identity of any place. Few case examples are selected from the fringe areas of Pune city based on the type of landuse & people's association with spaces. The assessment is carried out on the derived parameters. The paper will conclude with the findings and recommendations on the application of these parameters which add to the imageability of the fringes.

Keywords: fringe, identity, image ability, ecology

1. Introduction :

Today, due to the urbanization and opening of new industries has resulted in the change in the socio economic aspect of the fringe areas of the Pune city. This has resulted into the shift in the occupational pattern due to the emergence of postindustrial economy. Villages lying in the immediate vicinity of cities gradually acquire urban characters. This peripheral area potential for urban growth, known as rural-urban fringe have grown around all Indian cities and has assumed a vital significance for planning of cities in future. The villages of the fringe today are likely to become an integral part of city tomorrow. However, the rural-urban fringe area of cities express certain typical characteristics pertaining to economic base and social set up, increase in commuting population and conversion from agricultural to non-agricultural land uses. In the absence of any land use policy, fringe areas grow haphazardly. Generally, in these areas land transformations are highlighted within the city only, but what is actually happening is the alarming rate at which land is getting transformed in rural areas due

to unregulated urban sprawl. Urban influences change their outlook, way of living, occupational structure but it does not shed their rural character completely as there is lack of services and facilities. In the absence of any urban planning policy, the city grows in an unregulated and haphazard manner as the fringe agricultural land gets converted into urban uses. New development follows the norms and policies as recommended for the city. It divides the territory and develops under generic rules and policies. Such consequences lead to ignoring the context and immediate surrounding of the area. Due to these constant transformations, developmental pressures taking place in these areas has led to the loss of its own identity over the period of time.

Historical Indian cities with high density mixed use neighborhoods which have temple squares and markets forming nodes and open spaces were highly imageable, but due to urbanization they lose their imageability over a period of time. Similarly, in case of fringes, they are always seen as opportunities of investment due to mainly three factors: i) Availability of large land parcels, ii) availability of land at relatively low prices & iii) availability of infrastructure close to in the city. The spatial environment and everyday quality of life of people from the fringe regions get marginalized in the impromptu process of urbanization. The current planning processes tend to prioritize the city and disregard the fringe land's contextual social, spatial and cultural characteristics. Over the period of time, when eventually these lands are merged with the city, several potentials of the fringes not only remain untapped but deteriorate in quality. Hence, the intent of this research is to understand, establish the idea of imageability and identity for urban fringes of Pune city & find out flaws that fail to contribute to imageability of the area & develop recommendations, policy guidelines for imageability and identity for the fringes of Pune city. An important characteristic of fringe area is that they are neither purely rural nor purely urban. The fringe areas of Pune are no exception from the above discussed phenomenon (refer Figure 1). The city has been growing rapidly under urbanization, expanding its boundaries from urban areas to rural lands. In such a situation, it is quite predictable that the city shall face the problems over the period of time due to the spatial spread of the city; hence it is very important to analyze all such problems at the initial stages of fringe development.

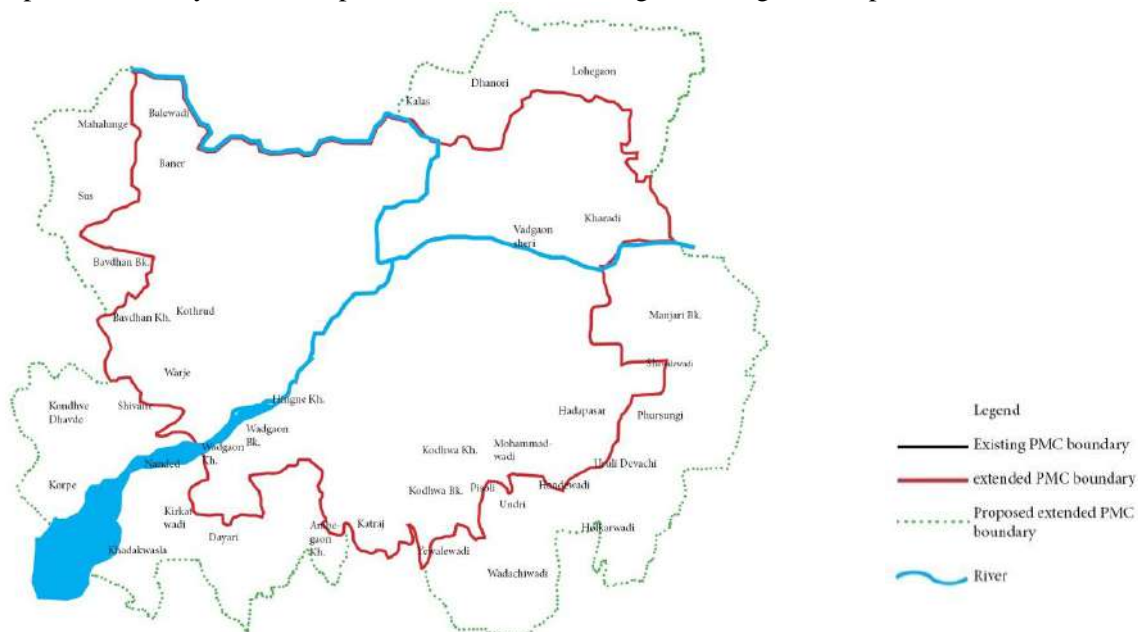


Figure 1: Map of fringe areas of Pune city. Source: Author

Hence, the objectives of this research is firstly to find out the parameters that contributes to the idea of imageability, identity to the fringe areas of Pune. Secondly, to find out the theories related to the imageability and identity of the place, assess these parameters in the context of fringes and establish the relevance of these theories on the urban fringes of Pune. In order to understand the idea of imageability, the term coined by various scholars need to be looked into.

2. Theory of Imageability by Kevin Lynch

The theory aims at understanding how people understand a city. It is stressed upon two important explanations - the physical elements of city consisting of natural and manmade components. Natural components such as air, sky, rivers, lakes, ponds and hills. Man-made components such as infrastructure, objects, vehicles and so on. Secondly, the psychological mental image of the city. Both natural & manmade factors contribute to build a perceptual form of urban environment. Imageability, the term coined by Kevin Lynch (1960), "is the quality of a physical object, which gives an observer a strong and vivid image..." it might also be called legibility¹. (Jothilakshmy). According to him the legibility of the city is, "the ease with which the city's parts can be recognized and can be organized into a coherent pattern"; this is significant not only for aiding practical tasks such as way-finding, but is central to the emotional and physical well-being of the inhabitant population, personally as well as socially. It is understood that by creating a distinction of the different elements as a separable entity, it makes it easier to identify the element and the city's parts can be recognized and organized into a coherent pattern, aiding way-finding, thus enhancing the imageability of any city. Visual quality of urban environment is the physical elements of environment and the mental image of its users. Users perceive an urban environment in its fragmentation into elements and patterns. All these perceptions are different, special and are related to user's knowledge experience or familiarity with urban site. Hence, imageability is highly influenced by familiarity, repeated direct exposure to an environment and familiarity is closely linked with place attachment. Place attachment is developed when a place is well identified and considered significant by the users and provide a condition that fulfill their functional needs. Imageability closely relate with distinctiveness, as human beings are more likely to recognize an environment with unique or distinct attributes because they tend to be more imageable². (Nurhimah Budi Hartanti). The presence of distinct elements that are visually recognizable, vividly identified and powerfully structured will strengthen imageability and ease observer's process of way finding.

The word 'image' has different meanings for different people; it is a kind of experience and may be a concept, plan, map and so on. Urban designers like Jacobs Jane, (1962), Spreiregen Paul (1965), Rossi Aldo (1982) and Gosling David (1994) had also defined urban imageability; they correspond to Lynch's definition of imageability. Some of the other definitions of image are – Study of Images is called "eiconics"³ (Boulding) and is used to emphasize that a city has different meanings for different people- the slum dweller, commuter, geography teacher or planner, i.e. it is used interchangeably with the perceived environment. Images have been described as the "points of contact between people and their environment" thus linking them to behavior⁴. (Downs). An Image stands for a notion, stereotype, plan or map, plan of action, concept and self-concept and so on⁵. (Amos).

2.1 Imageability Uses & Need

This research focuses on the imageability of the urban environment, its physical qualities, which relate to the different attributes of identity and structure, which enhance the legibility of the area. A city is a dramatic event in the environment. Cullen Gordon (1964) narrates vision thus: "If someone knocks at our door step and we open to let him in, it sometimes happens that a gust of wind comes in too, sweeping the room, blowing the curtains, and making a great fuss". Vision is somewhat the same; we often get more than what we look for. Vision is not only useful, but it evokes our memories and

¹ Jothilakshmy, N. (March 2011). *Evaluation of form based codes and the image of chennai, Tamil Nadu. chennai.*

² Nurhiknah Budi Hartanti, W. M. (2016). *The Quest for urban identity: Influence of urban morphological development to the imageability of Bogor city streets. International journal of research in engineering and science.*

³ Boulding, K.E, "The Image: Knowledge in life and Society, Ann Arbour University of Michigan Press, 1956.

⁴ Downs, R.M. and David Stea, "Image and environment: Cognitive Mapping and Spatial Behaviour", Transaction Publishers, 2005.

⁵ Rapoport Amos, "Human Aspects of Urban Form towards a Man- Environment Approach to urban Form and design"; Pergamon Press, 1977.

experience, those responsive emotions inside us, which have the power to disturb the mind when aroused. Enhancing the image is something similar to enhance the vision, which is more than organizing the different physical objects into a coherent pattern. The skeleton, an image which appears, is a particularly useful analogue for the idea of a city. For the skeleton links the city to history. It is the history which is limited to a pure knowledge of the past, without which, to determine the future is difficult. Thus, the skeleton, which may at one level be compared to the urban plan, while a general structure of parts, is also a material of artefact in itself: a collective artefact⁶ (Aldo).

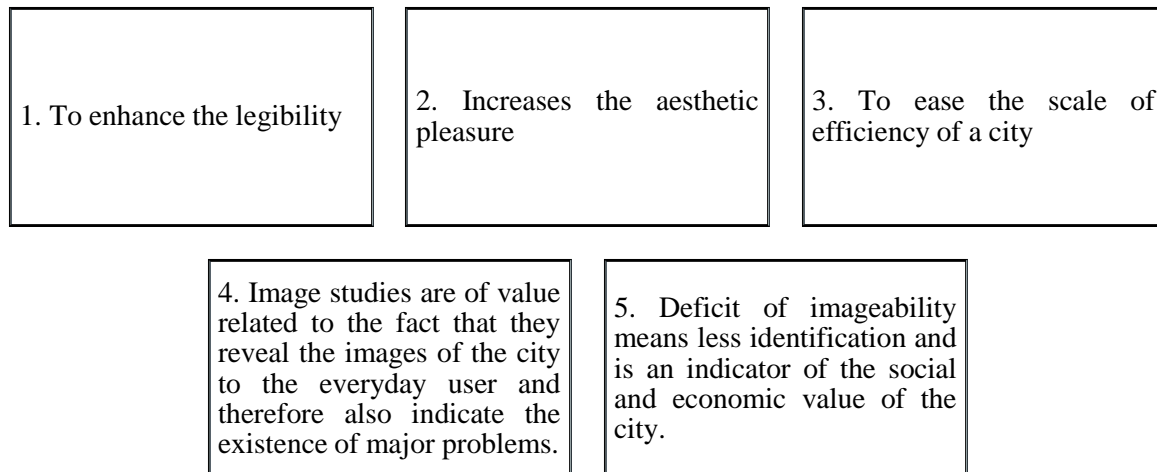


Figure 2: Uses of city image. Source: Author

History tells us that a good city evolves on the basis of local characteristics and design principles and not by mere change. History also tells us that good urban structures and forms enable and enhance urban activities, and improve on the well-being of the citizens. A good city is created by the balanced relationship between the local and global environment. A good city image is preserved and therefore long lasting because it functions well and expresses the history, the citizens' collective memory, values, beliefs, and pride. Taking the example of the walled city of Jaipur, known as Pink City for its predominantly pink/rose and complimentary colour schemes has seen a huge transformation in the culture, life style, socioeconomic condition and technology over the ages, yet it is one of most accessible and functional medieval city in India. But in case of fringe lands, which have gone into transformation and have no glimpses or traces of the history are questionable for their existence in today's world. The real challenge lies in identifying what all characteristics of the fringe areas need to be taken into consideration for it to have its identity or legibility. Hence for this research it becomes very important to understand what all elements/characteristics of fringes need to be taken into consideration in order to assess it for imageability.

The most important clue from which people choose to make a place more distinguishable, and which leads to strong imageability is physical difference. In this, the vision is measured by parameters, such as the type of objects, space quality, light and shade, greenery, visual aspects of perceived density, new vs. Old, well maintained and badly maintained, scale and urban grain, road pattern, topography and location. These are also included in the list of imageability parameters to evaluate the image of the city. Also, it is very important to understand the ancient planning principles of city planning which contribute to the aspect of imageability.

⁶ Rossi Aldo, "The Architecture of the City", The MIT Press, 1982.

3. Ancient Planning Principles and Imageability Elements

Cities will continue to change, grow or shrink, expand or contract, in order to adapt to changing socio economic conditions. The urban fabric is comprised of three interlocking elements. The first is the city plan itself, which consists of the street system, the plot pattern, land parcels or lots, and the building arrangement within this pattern. The second is the land use pattern, which shows specialized uses of the ground and space. Finally, there are the building fabrics, which are the actual three dimensional marks of physical structures on the land ownership pattern. The relation of a city to its parts is similar to that of the human body to its parts; the streets are the veins. Indian cities grew around early settlements and were planned on the basis of the principles canonized in a number of ancient medieval texts and treatises of town planning and architecture, such as the Vastushastra, the Manasara and the Samarangana Suthradhara; principles which reflected a deep concern for the pragmatics of town planning in terms of site selection, street networks, zoning controls, and even expansion⁷ (Doshi). A characterizing feature of the traditional urban settlement in India is a built environment that responds to the topographical and geological character that is unique to it. Each traditional city has a distinct character that is unique to it. This character is generated through the articulation of the built environment in terms of the various hierarchical levels of the city, its dominant institutions, its streets and open spaces and the building elements used. The built fabric of the city works as a passive climate control device. The various components of the cities relate to the whole resulting in a coherent and integrated entity.

The built fabric of the city works as a passive climate control device. The various components of the cities relate to the whole resulting in a coherent and integrated entity. During the British period, their system of planning was radically opposed to the traditional Indian. The dense urban fabric was associated with problems of hygiene, sanitation and fire hazards as in the case of British towns in the 18th and 19th centuries, and to establish a distinction with the rulers there were differences in the built form too. Post-independence, the high urbanization and urban agglomeration resulted in overcrowding the urban core with high energy and high resource consumptive and does not respond to the lifestyle of the people, their traditions and contemporary needs⁸ (Doshi). In ancient India, a sense of civic integrity gave rise to certain conditions, which can be referred to as controls. Some pertained to the order in which various tasks must be carried out. The town was to be laid out first and only then the houses were to be planned. The trees were to be planted first and then the buildings were to be erected. Building heights are specified to give a ward/sector a distinct identity. More structures were prescribed to be taller. The correspondence between the width of the street and the height of the street was worked out, such that the taller buildings of the elite were along the wider roads, while the shorter buildings of the lower classes were along the narrow streets. The harmony of built form was important. The heights of buildings along the same street were to be similar. A chronological outline of the major planning principles and image elements of different Indian cities as illustrated by B.V Doshi is as follows –

Sr.no	Name of the City	Major Planning Principles and Image Elements
1.	Mohenjo Daro and Harappa(Beginning of the civilization)	The inner city streets running straight and aligned north to south and east to west, intersecting at right angles and dense city structure.
2.	Pataliputra (founded in the 5th century B.C)	The social division was of typical royal cities with large areas for it, traders, crafts man had a separate street or bazaar, a pattern which is still there. The city is constructed with mud, had a flat roof and a verandah around an enclosed court.

^{7,8} Doshi Balkrishna, "An Approach to Planning Vidyadhar Nagar", Vastu-Shilpa Foundation, 1991.

3.	Varanasi: Banaras- Beginning of the civilization in North India	The structure of the town arises partly out of the geography of the place. The limits and zones of the city territory are maintained by the pilgrimage. The ghats form the major urban element, being monumental and picturesque, reflective of the close relation between the city and the river.
4.	Agra -founded in 1506 A.D	The city can be broadly divided into three areas: the fort area, a city within the city housing the royal functions, the city wall area for local commercial and public functions and the outer city wall area for regional commercial activities. Mostly it was mixed use and there exists a caste system with different areas for different groups of people.
5.	Ahmadabad- 1411 AD- 1572	The city's form, dictated by the Sabarmati river, is roughly semicircular with the main complex at the centre. The city within the fort wall had mixed activities. The fabric of the city is dense built form punctuated with house courts, public spaces and narrow winding streets. The buildings are of 2/3 storied structures. Primary streets were commercial in nature, secondary streets with specialized commercial and third order form housing clusters.
6.	Jaipur	Based on prastara principles prescribed in the Shilpa-shastra or vastu-shahstra, emphasis is given to the cardinal directions with modified grid layout 3x3 with main streets or paths being the grid lines. The built form and fabric of the city, the culture and traditions have a very important role to play in the imageability and identity of the city of Jaipur.
7.	Chandigarh- 1947	The integration of formal and informal sectors. The seven V's system & each sector having its own character. Self-contained sectors were planned with all facilities.
8.	Hyderabad- 1951	The dominant elements of the plan and architectural landmarks of the urban spaces represent the characteristic features of the organic gardens of eternity. Hyderabad was laid out around a monumental building in the centre, the Charminar with a Mosque on the ground floor and a large cistern above.

Source: (Doshi)

Thus various case references discussed above reveal that there was always a thought given on the overall form and image of the city and its parts, with respect to the different parameters addressing imageability and sense of place, and firmly establishing the relation between the built environment and the public realm. In addition, the regulations were created with the formulation of planning guidelines. In the current design and planning policies for an urban environment, some of the major aspects of imageability, namely, legibility and identity are lacking, and this research tries to fill the gap.

Parameters for imageability			
Sr.no	Parameters	Association & its connection with built form & morphology	Imageability & legibility
1.	I. Physical factors A. Natural resources: <ul style="list-style-type: none"> • River • Hill • Water channels • Land • Lake B. Topography C. Climate	River or water body has always been an important element for the formation of any settlement eg.the river valley civilization. There is a strong association and bond of human beings to live close with nature and also helped them develop their livelihood based on it.	The built form & morphology should respect the existing natural features and there needs to be the cognizance of the physical setting and surrounding.
2.	II. Historic factors <ul style="list-style-type: none"> • Temples • Monuments • Forts • Caves 	People are always associated with Temples/ monuments due to its religious and cultural importance. The settlements are often formed along these structures.	These act as anchoring elements for social life in community.
3.	Sense of place & space & its legibility	Due to the various transformations and changing trends of urbanization the association with place/space is lost resulting in the loss of sense of belonging.	People's associations & belonging to the area make the area highly memorable & help in creating the image.
4.	Broad Area level parameters <ul style="list-style-type: none"> • Type of fabric • Tissue characteristics • Land use • Density & size 	The type of fabric and connectivity between the tissues create a sense of association.	The density and the intensity of the use of land by people and buildings, urban texture and grain, show the degree of homogeneity or heterogeneity of the city.
5.	Open spaces	Open spaces such as social spaces, recreational areas etc. act as anchor points which create attachment.	Open space, is sometimes treated as a leftover, but it contributes greatly to the visual quality of the urban environment.
6.	Street & square	Streets and squares are considered to be most important public spaces in any area to which people associate with.	The spaces between the buildings and the streets such as the setbacks, and the different ways of integration of all the three elements, increasingly influence the visually pleasing form and image of the city.
7.	Transport network	People usually associate themselves with the connectivity or linkages of the streets/ path which would lead to the certain important places.	The linkages/connectivity between the transit routes or the ease of movement is what makes the memory.

8.	Proportion and Scale of Built space	On the matter of the effect of movement on scale and proportion, driving in a vehicle leaves little time for viewing and diminishes a person's capacity to absorb detail. Pedestrians have a better awareness of a place than drivers or passengers in moving vehicles.	
9.	Built form parameters		
	Building massing	Apart from changes to the landform and surfacing in the built environment, it should be understood by designers and planners that changes to the environs occur when buildings are grouped together.	
	Building use		Mixed use tends to keep the streets active throughout day & night as well due to the activities or the pedestrians which can enhance its image ability of it.
	Street width to building height ratio (Degree of enclosure)	Width of the street does not exceed the height of the surrounding buildings. Generally, buildings are likely to provide a sense of definition and also of a human scale when height-to horizontal- distance ratios are 1:4 when the viewer is looking at the buildings from the street at a 30-degree angle.	
	Building Orientation		
	Building Frontage Design	With building frontages onto public spaces is advantageous because the public edge of the building has activities which benefit from interaction with the public realm, and can contribute to the life of the public space itself.	The type of activities taking place in any space always tends to create an image in the observer's memory.
	signage/street furniture/ hoardings		The good designed signages and street furniture increases the legibility and hence enhances the imageability.

4. Current scenario of the fringe areas of Pune and its changing image

Taking into consideration the context of Pune & its urban fringe on which this paper is focussed on, the urban fringe encompasses low density urban regions in moderately thick vegetated lands. Landscape elements comprise of scenic hills, lakes and green fields. Fringe lands are also marked with various natural features that not only have aesthetic values but also define in a broader regional context significant ecological values. The surrounding fringe lands vegetation mainly comprises of forested hills. They have a very high value as they harbour various indigenous plants and species of medicinal and economic importance. Together with agriculture fields these play the role of a green belt for the city. Most recently, several small large residential schemes have come up in the area. Large scale and fast pace of migration is rapidly reshaping socio-spatial values and culture in fringe villages. In order to meet the needs of extreme population growth, construction projects by private developers are proceeding at a fast pace. Besides, the developed communities are large and gated. This trend may be perceived as a threat as the process leads to selection and enclosure. Unaware of the potentials of their lands, several farm owners and other locals sell all their fields to real estate developers at a unfairly meagre price. The latest response to urbanization, in which several farmers are themselves becoming developers as they join hands together with existing small/big local contractors in the area around. Of these most are uneducated and unaware of the long term impacts of their actions. So far, Pune's fragmented situation may be related to the top-down planning system which does not read and incorporate local identities. The new construction in the form of western models of multi-storeyed condominiums and generic architecture abutting the traditional housing typologies generate social divide at subtle levels. These with time are becoming very evident bringing in strong divide in communities and social groups. The local culture is fading and in general the gap in society is widening. The diversities of village cores, their contexts and unique qualities get eroded while the city caters to its needs at a regional scale. The probable consequences of disconnected plans for different parts of the city are fragmented development of fringe lands, declining agro economy, substandard and generic spatial forms, degrading environment, air pollution, unjust socio-spatial hierarchies and low quality of life which are becoming urgent problems associated with Pune's fringe areas. The challenge is to find an approach to integrate solutions for the existing & new development at local & regional scales, and a right balance between urban & natural systems.

From the above study, the standard parameters important for imageability for the fringes need to be taken into consideration and hence we assess two cases of fringe areas in Pune city. The case examples selected for further study are kirkatwadi village & Bhugaon village around the Pune city.

5. Case Examples

5.1 Kirkatwadi Village

Kirkatwadi village is located in the south west quadrant of Pune region. The main feature of this village is its setting in the rich natural surroundings. However, the hilly terrain, uncertainty of rains and increasing pollution has reduced the agricultural value of these lands. Several locals from these village commute to nearby urban centers for clerical jobs. Due to the increasing developmental pressures like the need of housing and also because of low land rates, the area is developing for residential use, mainly for people working in service industries. The village's socio spatial structure of community is rapidly changing as are its economic trends. Social anchors like temples and traditional congregation squares have lost their meaning in unplanned rapid urbanization as the Kirkatwadi village road is now been also used as a thoroughfare due to which the village is losing to its social and public space. The gated communities abutting the traditional housing typologies have generated social divide at subtle levels. Currently due to the stereotypical housing typology, the area is facing identity crises. The developmental pressures act as threats to the economic, social and cultural identity of the village. Various parameters assessed to understand the imageability of the area are as below:

A. Physical factors

I. Natural resources: river, hill, water channels, land, lake

II. Topography

III. Climate



Figure 3: The agricultural lands producing major crops such as rice, jowar. Source: Author



Figure 4: Rich natural surroundings & productive landscapes.

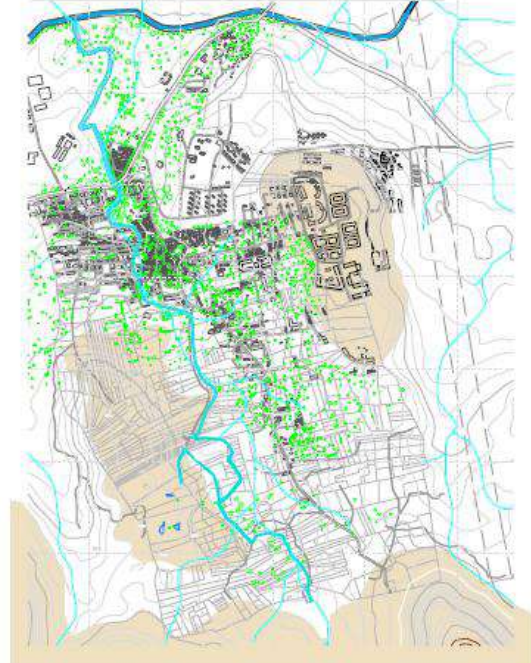


Figure 5: Village map of Kirkatwadi. Source: Author

The village is situated in a rich natural setting consisting of hills, water channels and parcels of productive landscape. Agriculture remains the main economic activity which primarily depends on the natural rains, streams and pumped water from wells. The village is located in proximity of Khadakwasla dam & Sinhgad foot which gives it a rich ecological, cultural sensitivity.

B. Historic factors: temples, monuments, forts, caves



Figure 6,7: Temples and traditional congregation squares have lost their meaning in unplanned rapid urbanization

Due to the increase in movement on the main spine of the village road, the temples and public square has more been thoroughfare losing on to its cultural identity. The place which was previously used by the locals for chitchatting, gatherings etc is now used for parking cars, bikes etc.

C. Sense of place & space & its legibility



Figure 8: The gated communities abutting the traditional housing typologies have generated social divide



Figure 9: The haphazard development leading to loss of identity crises.

Place attachment basically refers to people's bonds with places. Place attachment is developed when a person becomes familiar to a particular space/place. Due to constant transformation in the fringe areas the association of the locals with the place is lost resulting in loss of sense of place. The public gathering spaces, common meeting areas have lost their importance due to the village spine becoming thoroughfare.

D. Type of fabric: Tissue characteristics, land use, density & size

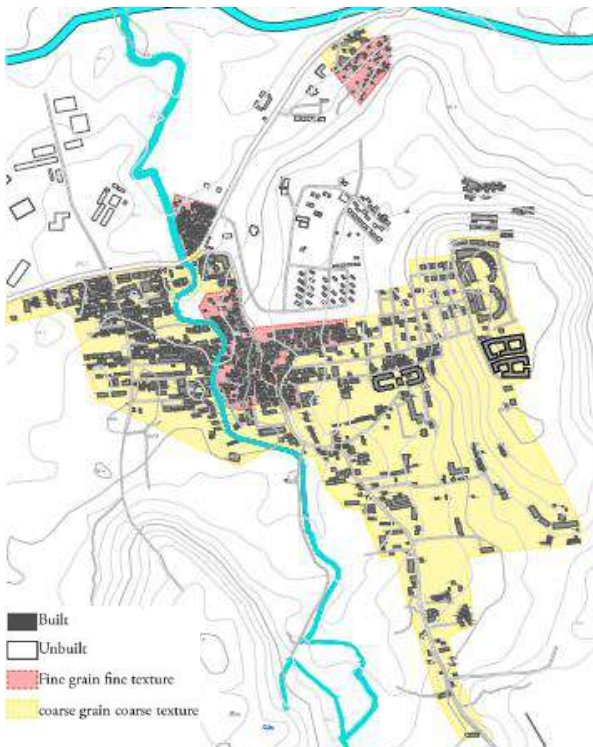


Figure 10: Figure ground map. Source: Author

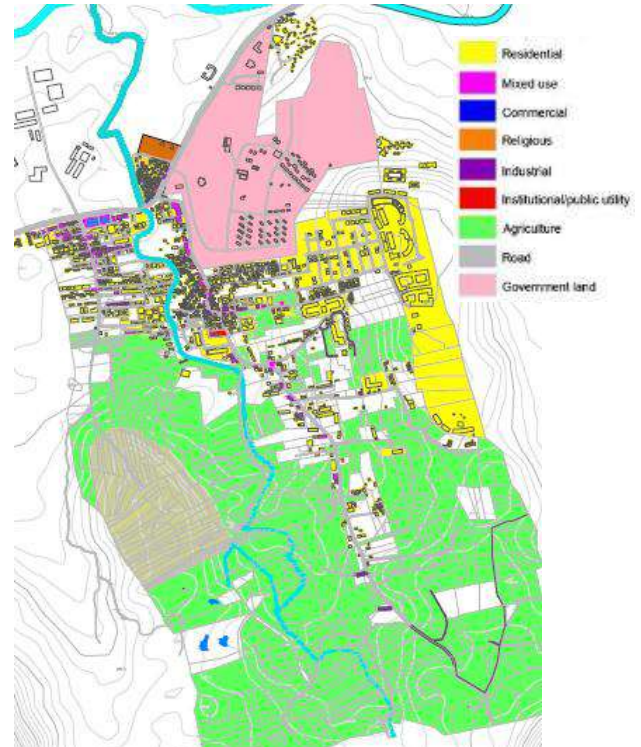


Figure 11: Land use map. Source: Author

The fabric consists of a mix of two grains such as fine grain fine texture & coarse grain coarse texture, resulting in the mix of two types of social class in an area. The land use majorly consists of residential areas & mixed use. The majority land parcels consists of agricultural lands producing food for the nearby areas. All new development should consider the opportunity to encourage a mix of uses that contribute to the economic and social health of the area. Large development proposals should provide a mix of housing type, form and tenure. A compatible mix of uses should include live/work units.

E. Street & square



Figure 12: The common gathering spaces/squares becoming parking lots & thoroughfare. Source: Author



Figure 13: Inaccessible & fragmented street network. Source: Author

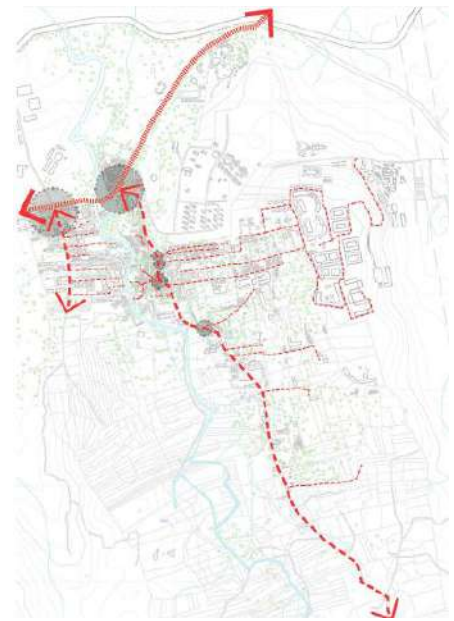


Figure 14: Street network showing accessible & non accessible streets. Source: Author

The fragmented street network has led to unplanned areas which has increased crime rate. The observer feels lost when he is travelling on such roads. Such incomplete street networks create voids & grey areas increasing acts of vandalism.

F. Building use

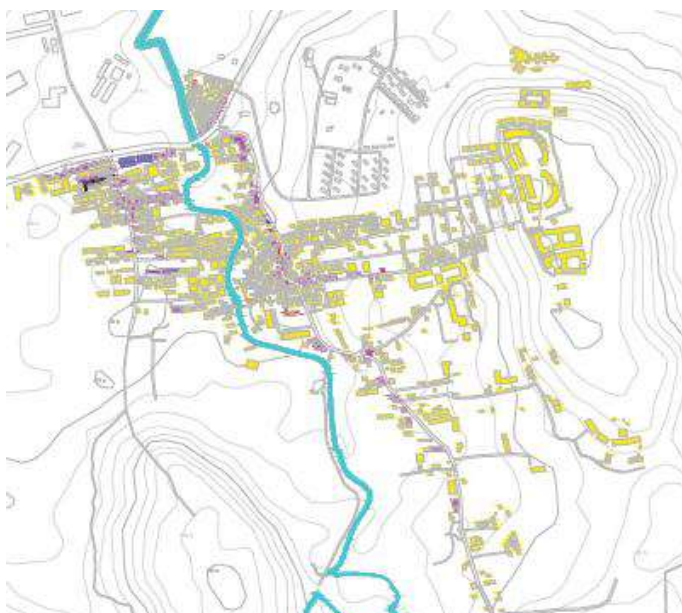


Figure 15: Building use map. Source: Author

Dominance of residential land-use has led to inactive areas during day time. People choose to work in the neighbouring areas or in the city and live in Kirkatwadi. Development throughout the area should discourage single storey, single use development. A variety and intensity of street activity should be encouraged. A continuous retail edge at the property line can be promoted which can help keep the area active during the day as well as at night. Complementary uses can be mixed horizontally (side by side) or vertically (on different floors of the same building).

G. Street width to building height ratio (Degree of enclosure)

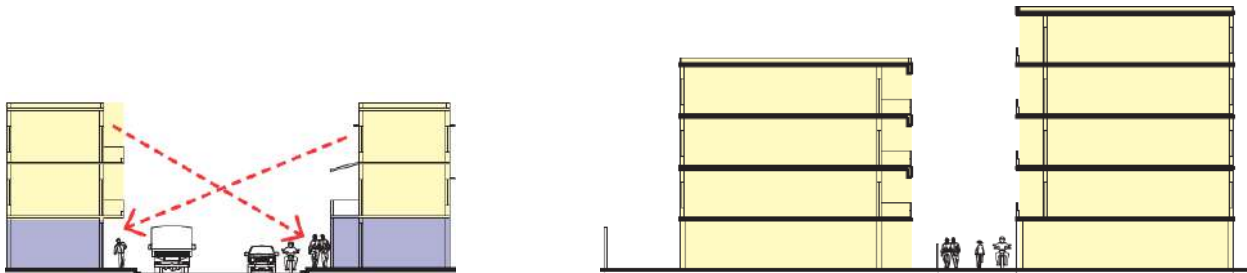


Figure 16: Schematic section showing street interaction & enclosure. Source: Author

Due to absence of any bye-laws there exists issues of light and ventilation as there has been no such byelaw for the street width to building height ratio, leading to liveability issues.

New development should respect the historic street patterns, intricate grain, and vertical and horizontal rhythms (e.g. the building widths, the proportion and scale of windows and doors etc.) of the Town Centre. Opportunities to repair street pattern and grain where this has been lost should be exploited.

The relationship between the height of the buildings and the width of the street is important when maintaining a pedestrian oriented environment. A two-storied building (approximately 27 feet high) will give a height to width ratio of 1:3.



Figure 17: Building having no setbacks, issues of light & ventilation. Source: Author

H. Building Frontage Design



Figure 18: Weak street edges, absence of pedestrian infrastructure, insufficient parking lots.

Active building frontage helps in creating public life in the area which helps in keeping the streets active. The primary access to buildings should be directly from the street. The main entrances to public and other major buildings should be emphasized through carefully designed streets, lighting, signage and paving.

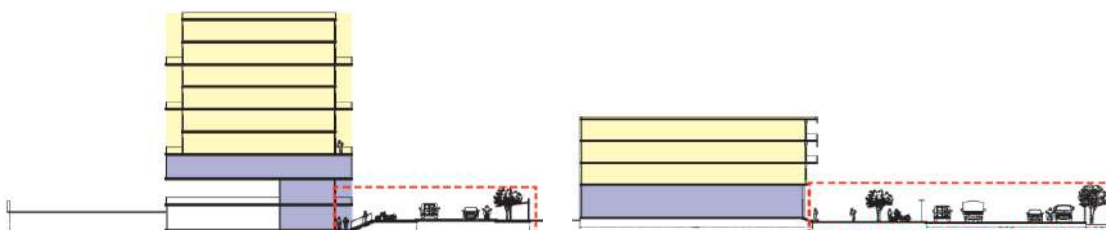


Figure 19: Schematic section showing active street frontage

I. Style of dwelling



Figure 20: Determining the topology of dwelling which integrates with in the existing fabric is also important.

The style of dwelling or the typology depicts the cultural history of the area and the locals have a sense of association with it. Taking into consideration the type of area a compatible mix of uses should include live/work units. There is a need to create a skyline which adds visual interest and conveys particular activities and concentration of uses making the area busy all throughout the day.

J. Elevation/facade treatment



Figure 21: Mix in the type of elevation & facade treatment as many new structures have come up which have a contemporary use of materials. Source: Author

Development at strategic corners should emphasis their importance through the use of building height, prominent entrances and other architectural features. Close attention to the detailing and quality of materials should be provided especially at ground floor and building entrances that are very visible to pedestrians. The windows are a key component of the façade that help define a building's character and provide underlying order as well as its overall proportions. Care needs to be taken to ensure that the windows are of an appropriate scale to the façade, and that each window in the façade has some relationship with the other. Too many different types of windows, particularly if they appear to have no apparent relationship to one another, can result in an untidy façade. The use of materials needs to be considered both in terms of the relationship with the surrounding built form as well as the articulation of a façade. Use of different materials can help to articulate and add interest to a façade.

5.2 Bhugaon Village

Bhugaon is located off the Mumbai-Bangalore national highway, by-passing Pune city. Today, due to the development of institutions the area is getting transformed leading to development of new residential and institutional areas. Also, the current chandani chowk interchange which is under development & the ring road has made a great impact on the village. Such huge infrastructure developments lead to the attraction of investors, builders in the area for profit making. Due to this uncontrolled & fragmented development, the area lacks in terms of imageability and identity. Also, the increase in the institutions has led to increase in the number of hostels in the area leading to new typology of built mass. The area is losing its inherent rural character due to this urban influence. The newer development spreading all over the area is engulfing the village which has its own unique culture & built form.

A. Physical factors

I. Natural resources: river, hill, water channels, land, lake

II. Topography

III. Climate



Figure 22: Context & surrounding of village. Source: Author



Figure 23: Village map of Bhugaon. Source: Bhugaon studio, PVPCOA

The village sits into a valley consisting of hills on its two sides and river Ramnadi flowing in between the two hills make it unique in its context. The proximity of Manas Lake to the village makes it ecologically sensitive area.

B. Historic factors – temples, monuments, forts & caves



Figure 24: Temples & public squares losing its identity due to the increased traffic & haphazard development. Source: Author

The temples which act as social anchors for the area are facing a threat due to the increased traffic movement along the main spine of the village.

C. Sense of place & space & its legibility



Figure 25: The change in typology of housing leads to loss of sense of place. This leads to loss of people's association & sense of belonging to the place. Source: Author

Due to the increased urbanisation and developmental pressure such as housing the area is getting transformed at a faster rate. The new construction along with the existing old fabric has no cognisance of its immediate surrounding leading to loss of sense of place.

D. Type of fabric - tissue characteristics, land use, density & size.



Figure 26: Village map of Bhugaon. Source: Bhugaon studio, PVPCOA.

The piece meal kind of a development leads to creating of voids in an area which can also initiate crime rate in the area. The land use majorly consists of residential areas & few land parcels of mixed use. The majority land parcels consists of agricultural lands producing food for the nearby areas. All the new development coming up are gated communities having larger footprint & facilities.

E. Street & square



Figure 27: Street network of Bhugaon. Source: Bhugaon studio, PVPCOA.

The street network does not follow the contour profiles & hence the streets are developed perpendicular to the contours instead of parallel. Also, the interrupted/disconnected street network leads to development of grey areas & increase of vandalism in the area. Street and square tend to be places for public interaction and help in keeping the area active. Due to the increased vehicular activities along the thoroughfare/square which was once the most important place of public realm for the locals.

F. Street width to building height ratio (Degree of enclosure)

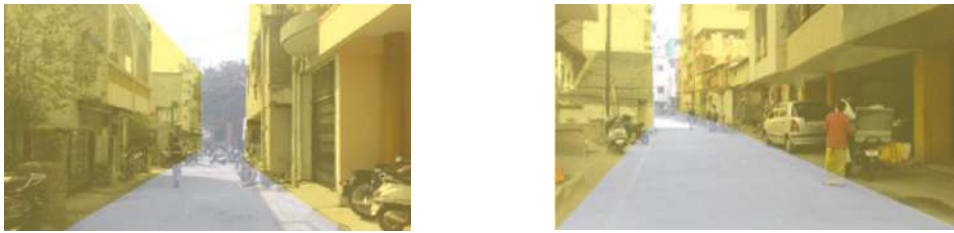


Figure 28: Absence of any guidelines for setbacks, height of buildings leading to livability issues. Source: Author

Narrow lanes having no proportion of building height to street width leads to poor quality of light & ventilation and discomfort to the viewer and also affects the shaded space during day.

G. Building Frontage Design



Figure 29: Weak street edges, improper parking of vehicles. Source: Author

The area lacks pedestrian infrastructure and also utilisation of building frontage in an appropriate manner which often leads to conflict in vehicular and pedestrian traffic. The weak road edges tend to create problems such as unauthorised parking lots, dumping of garbage in front of the shops, etc.

H. Style of dwelling



Figure 30: Numerous typologies emerging without any cognizance with the existing surrounding. Source: Author

The style of dwelling depicts the essence of the place. But due to the rapid transformations various typologies have emerged. The new typologies are gated communities with no resemblance with the surroundings, trying to establish their own image in the area.

Massing of the building varies at different places according to the street orientation and building orientation. Depending upon the orientation of the road the suitable building orientation varies. The best suitable orientation for the Street- should be oriented to utilize the natural wind patterns- south east to North West and buildings perpendicular to these streets will have the maximum natural ventilation. North faces receive the minimum radiation and south receives the maximum. Also, it becomes vital to respect the natural surroundings such as hills, water bodies, views, vistas & climatic conditions of the area while we design the typology.

I. Elevation/facade treatment



Figure 31: Stereotypical facades/elevations coming up. Source: Author

The traditional buildings have lost its significance due to the emergence of new development consisting of contemporary materials and elevations and absence of planning laws has led to liveability issues.

6. Recommendations & conclusion:

Sr.no	Imageability Parameter	Recommendation
1.	I. Physical factors A. Natural resources: <ul style="list-style-type: none"> River Hill Water channels Land Lake B. Topography C. Climate	Natural features such as water channels, hills, and river are highly imageable and people associate with them. Hence, these tend to be the important parameters which give identity to the area. Fringes possess a dominance of natural factors, being outside the city limit and sited into such physiography it becomes necessary to respond to the context as these factors tend to have a greater impact on the observer and hence in creating the memory or belonging towards one's place.
2.	Historic factors <ul style="list-style-type: none"> Temples Monuments Forts Caves 	Such factors act as anchoring elements for social life of a community. These are generally the places the locals of the area associate with. Also, generally, in villages, these temples also become spaces for social interaction which make them highly imageable.
3.	Sense of place & space & its legibility	When such areas get merged into the city, aspects like place attachment is always neglected. It is the richness of the place, the special environment and everyday life of people get marginalized losing to its socio- cultural values which lead to deterioration of its potential areas.
4.	<ul style="list-style-type: none"> Type of fabric Tissue characteristics Land use Density & size 	The type of fabric and connectivity between the tissues create a sense of association. Hence in an area there can be a combination in the grain size which can bring in the play and different character to certain areas. Also, variety in land uses can offer wide range of choices for the people.
5.	Street & square	There has to be a hierarchy of streets leading to important destinations which can help the observer in way finding. Creating proper loops can help reaching the destination in shorter period of time and can also enhance the experience of the observer along the street.
6.	Building use	Mixed use enhances imageability, especially if it is on the ground and first floor.

7.	Street width to building height ratio (Degree of enclosure)	Enclosure ratio of 2:1 to 1:1 normally provides a well-proportioned street frontage, which provides a good sense of enclosure. Anything less than a 0.4:1 height to width ratio can result in streets, which suffer from too little enclosure, where the buildings appear divorced from the street. Generally, buildings are likely to provide a sense of definition when height-to horizontal-distance ratios are 1:4 when the viewer is looking at the buildings from the street at a 30-degree angle. The most comfortable pedestrian streets are those where the 'width of the street does not exceed the height of the surrounding buildings'. (Ratio; 1:1).
8.	Building Frontage Design	Active building frontage helps in creating public life in the area. Encouraging compatible uses within the buildings to spill out into the public area Even if there are no public uses, most buildings contain activities which can contribute to the public space itself. It is still necessary to preserve the privacy of the indoor activity, so that the users will not feel the need to screen them totally from the public space. This privacy can be achieved by horizontal distance, a change in level and/or a combination of both. The usefulness of the edge is important for people-watching and is greatly increased by the provision of places to sit.
9.	Style of dwelling	When fringe areas get merged within city, the spatial environment & everyday life of people get marginalized. Several nature plausible potentials of the areas not only remain untapped but also deteriorate in quality. Hence, it becomes important to understand such factors as these tend to add-on to the image of that area.
10.	Elevation/facade treatment	Elevation and facades can be treated in a way that it can create an identity for the area.

Thus, from the identified parameters recommendations are drawn through the case studies which can be helpful for creating identity of any area. Also, the fringe case studies selected for this research are villages which are just merged with in the PMC limits but there are many such areas which are outside the PMC limits & possess their own rich ecological, cultural & social essence. Also, the people's needs & associations vary in both the scenarios. The limitations of this paper is that only the case specific imageability parameters are identified in the case study area to enhance the Imageability. While it needs to be understood that any fringe can be taken as a study area and the other imageability parameters at any level (Micro/Macro) may be considered to enhance the imageability, in its context. The inferences that can be drawn are that the planning for fringe area needs to be tailor made & complementing to the existing fabric, associations of people & help in the development of imageability aspect of that area rather than trying to built upon a new image which is not rooted with in the place.

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Transformation of Islamic Style Geometric Patterns from Traditional to Modern approach in Design of Facade using automation.

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Abstract: Islamic geometric patterns are a depiction of "spiritual unity". Islamic geometric patterns have been used for centuries as decorative elements on walls, ceilings, doors, domes and minarets. Geometric patterns used today are mostly static in nature for aesthetic purposes only. There are many types of star-shaped geometric patterns, namely 4, 6, 8, 10, 12-point pattern etc. The 6-point star pattern has 1-point control and the 8-point star pattern has 2-point control, which can generate new alternatives of parametric variations of the pattern. In short, new geometries can be generated.

This paper analyzed the transformation of the 4- and 6-point star pattern into three different variants in a single module using tools and techniques. One pattern is transformed into three new patterns using sensors and automation. The designed module is then used as a Dynamic shading screen with respect to Kinetic facade on the Mall building. By examining the three possible combinations of geometric components within the pattern, it will be possible to identify desirable systems of proportions for the design of the kinetic facade.

This will help researchers to further study the effects and use of the newly generated parametric patterns not only on the facade, but also on other architectural elements with regard to the climate, topography of the area where it is to be designed.

Keywords: Islamic Geometric Patterns, Pattern Generation, Parametric Modeling, automation.

1. Introduction:

Islam has a remarkable influence on art and architecture. The term "Islamic" refers not only to a religion that has spread throughout the world, but also to a culture and civilization that has existed for centuries. Iconography was forbidden in Islam, Islamic artists created and developed geometric patterns representing Islam. Islamic geometric art is based on complex geometric patterns that show the level of precision of the artists of the Islamic world. Islamic geometric art developed a true symmetrical design, while it has a strong background of the early Byzantine and Ottoman empires, where the exploration of geometric patterns with exquisite blends can be observed.

Islamic geometric patterns are based on the geometry of the Greek mathematician Euclid, who is known as the father of geometry. Geometric patterns can be divided into three types: calligraphic, arabesque and space-filling. The calligraphic designs consist of verses from the Holy Quran written in Arabic. Calligraphy (Figure 1) is also associated with geometry, as the scale and proportions of the letters are formed by pure mathematics. Arabesque patterns (Figure 1) consist of spirals, creepers, and plant motifs that mimic nature and divine adobes, and are usually found in the decoration of mosque

walls. Space-filling patterns (Figure 1) are made up of basic shapes with the formation of continuous patterns. All these patterns, visual appearance and principles of organization are complementary elements to the unity of Islamic art. (Mohamed Rashid Embi and Yahya Abdullahi 2012)

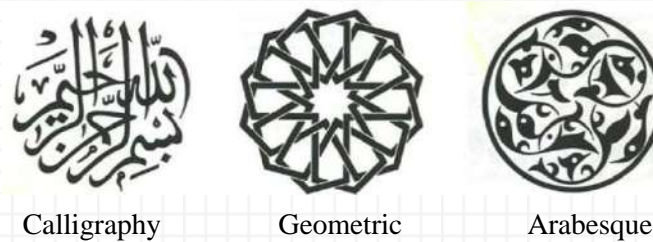


Figure 1: Geometric patterns classifications.(Serkan Baykusoglu ,2009)

1.1 Principles and features of geometric patterns: (Mohamed Rashid Embi and Yahya Abdullahi 2012)

- Symmetry:** Defined as a pattern. It is a representation of geometric shapes and there is a balance and harmony of proportions between their basic structures. The three types of symmetric functional aspects are reflection, rotation, and translation.
- Repetition:** Represents the eternal nature of God and the repetition of geometric pattern units. example: in shapes like a square or a hexagon.
- Scalability:** Geometric patterns can be uniformly scaled from large to small or from small to large depending on the arrangement and behaviour of the pattern.
- Adaptability:** Elements of Islamic art can be applied using various techniques.
- Frames:** Geometric patterns are framed or placed in the measured surface.

2. Objectives:

- To explore the 4- and 6-point star pattern and generating iterations.
- Finding a solution to transform one pattern into three new explored patterns using Rhino and Grasshopper.
- Provide a solution for the automation of the module to be applied to the facade.
- Application of the designed module to the facade of the Mall building.
- Study and analyse the influence of the external environment on the designed facade module.

3. Methodology:

- A preliminary literature review regarding the main concepts of facades and their meaning is understood by reviewing the related literature.
- Survey of Islamic geometric pattern types with reference to the published and unpublished research papers with a conclusion.
- Design process, generating iterations of the 4-point and 6-point star pattern using one module using Rhino and grasshopper, and formulating a solution to automate it.
- Application on mall building, Analysis and study of Dynamic shading facades using tools and techniques.
- Conclusion and future scope.

3.1 Preliminary literature review:

Façade (a French word) is usually used for the elevation or exterior of a building (not just a front view, but since its literal meaning is a face or front, it is taken as such). It has always been the interface between the building and the environment. Facades can be entrusted with several vital functions that determine the energy consumption of the building, which determines the quality of the indoor environment. It has great importance and is considered a significant aspect in architectural design, as it acts not only as an envelope of interior spaces, but also has an aesthetic value and creates an image of the building, becoming an icon or a landmark. The concept of efficient facades that adapt to environmental conditions dates back to when windows and ventilators were designed in response to

site conditions. In general, facades are designed to respond to many scenarios and perform functions that may contradict each other: daylighting versus energy efficiency, ventilation versus views, and energy production. Over time, thanks to constant research and development, architectural tools and materials have evolved, resulting in major changes in the design of facades and structures. The very concept of modern architecture arose at the moment when the domain of "building art" began to be consciously and explicitly placed in relation to the ideas of modern society. Figure 2 presents a brief history of the development of facades from the 19th century onwards. The term skin was originally coined to continue the distinction between cladding and the structural 'bones' of a wall, but has more recently been associated with the concept of cladding as an intelligent environmental system. (Mahina Reki and Semra Arslan Selçuk 2012)

Evolution of Facades from 18 th Century to 19 th Century	
1800-1900	Industrial Revolution 1760-1840
	Jayne Building Philadelphia (1849)
	Crystal Palace London (1851)
	Savoy Theatre, London (1881)
	La Sagrada Familia, Barcelona, Spain (1882)
	Home Insurance Building, Chicago (1885)
	Eifel Tower, Paris (1887-89)
	Rand McNally Building, Chicago (1890)
	Ingalls building, Cincinnati (1903)
	Villa Savoye, France (1929)
1901-2000	Chrysler Building, New York City (1930)
	Empire State Building, New York City (1931)
	Bridgers And Paxton Solar Building, Albuquerque, (1956)
	Guggenheim Museum, New York City (1959)
	Sydney Opera House (1973)
	Institut du Monde Arabe, Paris (1987)
	Kranichstein Row Houses, Germany (1991)
	Matitone, Genoa, Italy (1992)
	Lewis Center For Environmental Studies, Ohio (2000)
	Philip Merrill Environmental Center, Annapolis, Md (2001)
2001-2021	Turning Torso, Malmö, Sweden (2005)
	Cctv, Beijing "3d Cranked Loop" (2008)
	Burj Khalifa, Dubai (2010)
	Heydar Aliyev Centre, Baku, Azerbaijan (2012)
	Al-Bahar Towers, Abu Dhabi (2012)
	Wusun Apartments, Shanghai (2014)
	Kiefer Technic Showroom (2015)
	Lab building, Graz University of Technology (2016)
	The India Pavilion (2020)
	One of the largest pavilions at the Expo 2020 Dubai

Figure. 2 Evolution of facades 19th century - 21st century (Mahina Reki and Semra Arslan Selçuk 2012) (recreated by author)

The concept of kinetics in the approach to architectural design is not a new phenomenon. Although in engineering, the understanding of mechanisms and kinetics began a long time ago. The work of early scholars provided a basic understanding of kinetics and laid the foundation for several ideas for the realization of kinetic facades. **Kinetic facades:** Today, the application of responsive elements in a building, such as kinetic facades, play an important part in a building's operation. Kinetic facades are envelopes designed for high-performance buildings in response to environmental conditions and aesthetics. The architectural examples, to name a few that have revolutionized the façade design from being a static curtain to a living/ breathing skin, are stated in Figure.4

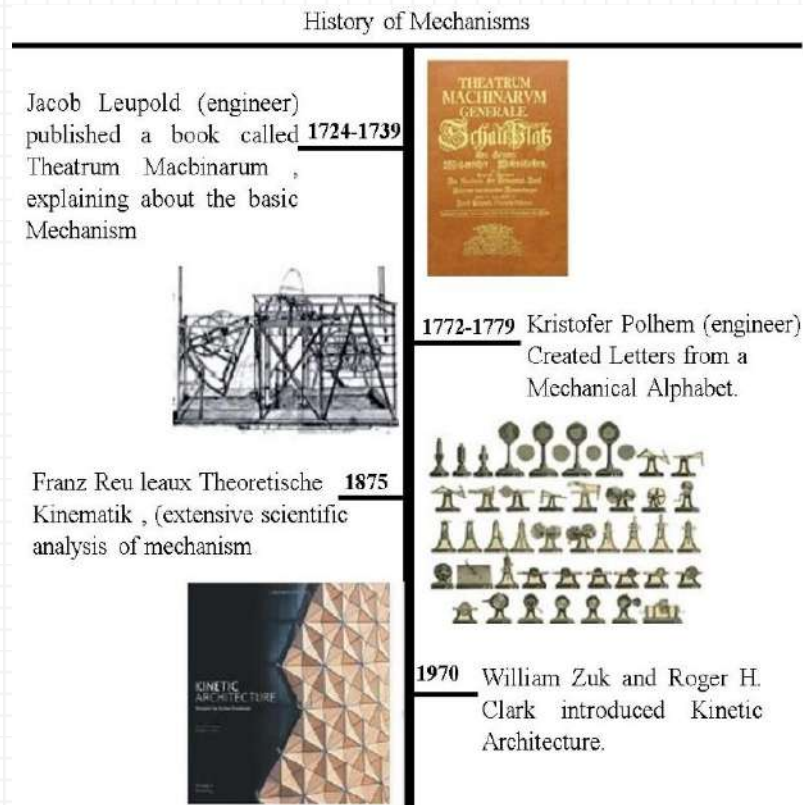


Figure 3 Mechanical engineering to kinetic architecture
(Mahina Reki and Semra Arslan Selçuk 2012)
(recreated by author)

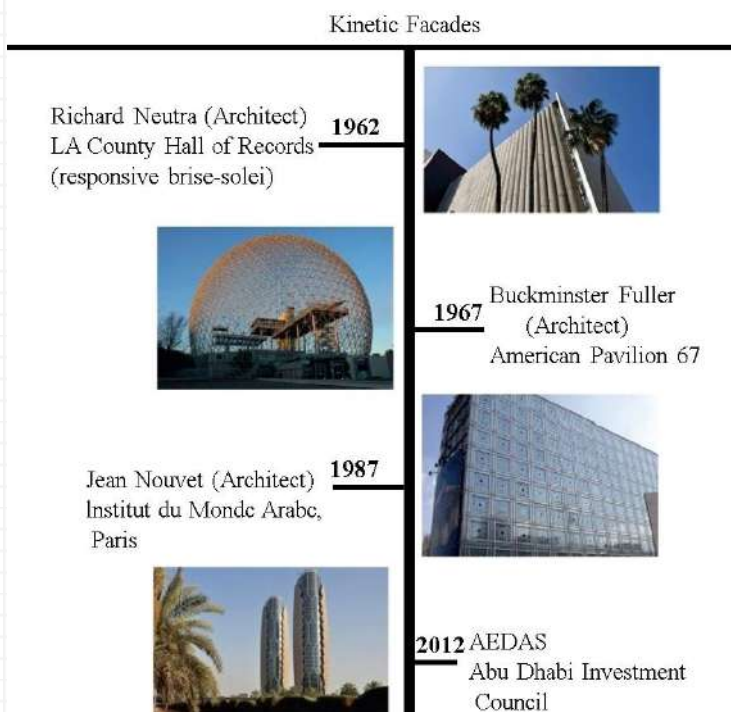


Figure 4 Examples of kinetic façades, responsive the surrounding environment.(Mahina Reki and Semra Arslan Selçuk 2012) (recreated by author)

Figure 5 Kinetic facades (a) Institut du Monde Arabe, Jean Nouvel (Michler, 2010); (b) Simons Centre, Stony Brook University in New York (Hoberman, 2010), (Mahina Reki and Semra Arslan Selçuk 2012)

Another notable example of the kinetic screens is the Simmons Center at Stony Brook University, an architectural wonder designed by Chuck Hoberman and Perkins Eastman. The screen consists of the four layers of perforated stainless-steel plates. Three of the panels are motorized layers of geometric panels that react to the temperature changes. The screen effect is like a flower, the tessellation appears to blossom into an explosion of new geometric patterns - hexagons, circles, squares, triangles, and opaque meshes, but when the patterns align, the maximum of light is possible. Over years many researchers have focused on generating types of patterns in terms of Islamic geometry. The research papers that are published and unpublished on website and other media contain the general information on types but less information on its mechanism. The focus of the paper will be both on pattern generation and its mechanism.

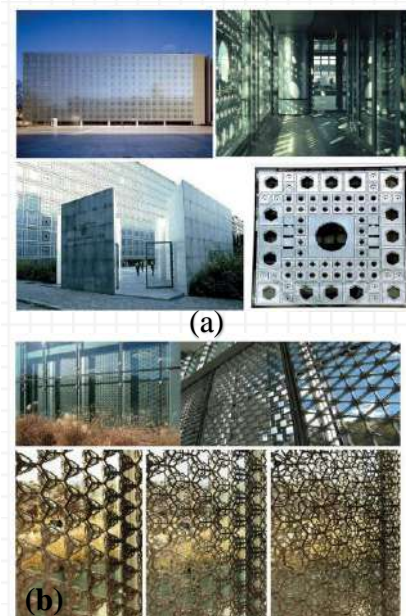


Figure 5

3.2 Exploration of types of Islamic Geometric patterns :

The formation of Islamic geometric patterns relies on mathematical precision and structuring. Circles serve as the primary structural element of grid geometric patterns, as most patterns radiate outward From a central point, forming repeating patterns and designs. (Figure 6)

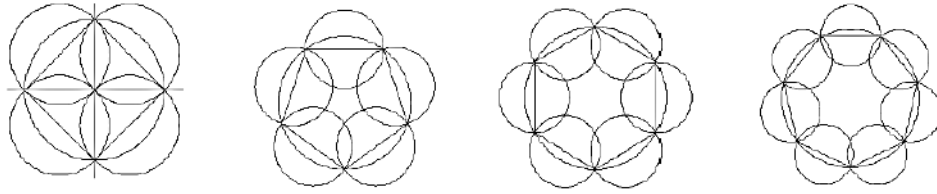


Figure 06: Primary level geometric patterns generating from circular central element (Alam.H. and Tasnim, S.T. 2021)

A circular base has been shown to be able to create infinite patterns such as 4, 5, 7, 16, 32, etc. Based on this concept, various geometric patterns can be typified according to the number of edges. The simplest are 4 points, 5 points, and 6 points. Further developments can be made by multiplying the quadratic circular element.

No. of Edges	4-point	5-point	6-point	7-point	9-point
Plane Figure					
Star					

Table 01: Islamic Geometrical Patterns Based on No. of Edges (Alam.H. and Tasnim, S.T. 2021)

Over the years, Islamic geometric patterns have evolved stepwise in terms of pattern formation. For example, a 4-point pattern was initially formed, and the 4-point patterning scheme was sometimes adapted to multiply versions such as 16-point, 32-point, 64-point, etc. Moreover, patterns have evolved to become more complex depending on the building design scheme and area proportion (Table 02). This also applies to other basic formations such as 5 points, 6 points, 7 points and 9 points.

3.3 Design Process:

Analysis of 6-point star Fundamental unit.

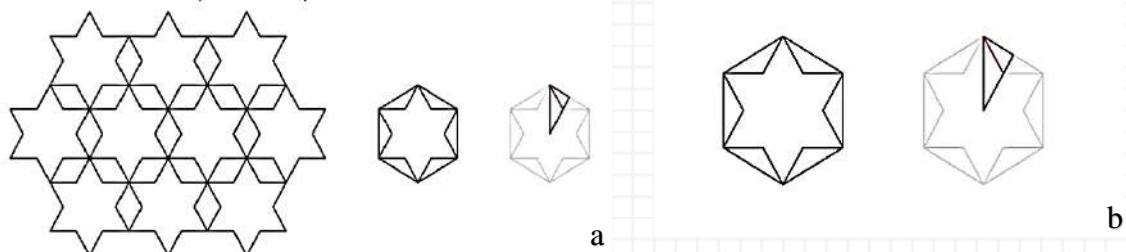


Figure 7 : shows a cell and the extraction of the non-symmetrical geometrical component, the fundamental unit. (Carlos Barrios and Mostafa Alani 2015)

The geometric component of a cell can be decomposed into triangular polygons enclosing the basic

unit, with one vertex at the center of the cell and the other two vertices at the edges of the cell.

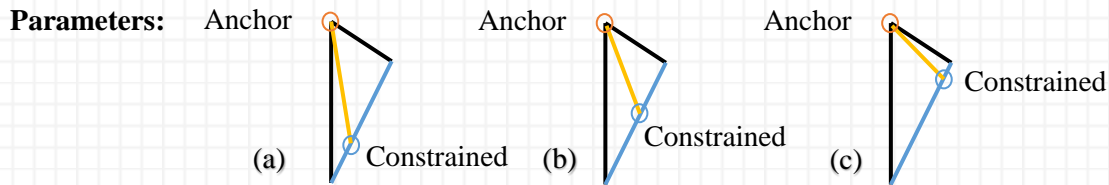


Figure 8: Parametric variation of one unit for the six-point star cell. (Carlos Barrios and Mostafa Alani 2015) (recreated by author)

In the above Figure 8, it can be observed that anchored points are fixed and constrained points move along the Yellow line in the bounding polygon. Experimentation on the Geometry of 4-star pattern to generate variations by changing the parameters. The movement and change in the point of anchoring can develop variations and new geometric patterns using Rhino and grasshopper

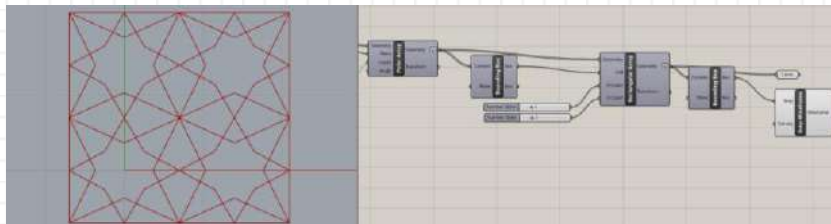


Fig. 9: shows the cell of 4 units of 4- star pattern using rhino and grasshopper

Now let's generate the pattern variation using the software and by changing the constraints

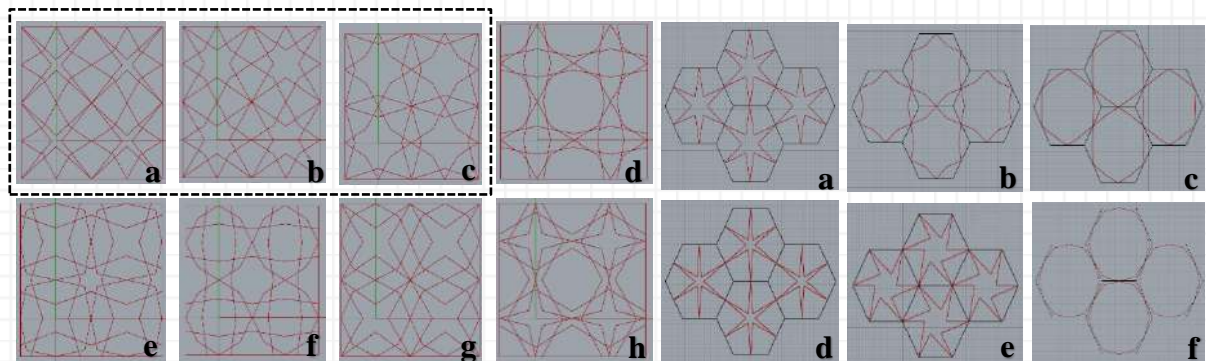


Figure 10: Iterations of the patterns of 4- point star Star

generated using the software.

Fig.11 Iterations of the patterns of 6- point Star

generated using the software.

For both the geometry of 4- star and 6-star, new variations in patterns generated can be seen in the above figures i.e., Figure 10 and figure 11. The purpose of the research is not only to generate patterns but also generate a workable basic module that can be used for kinetic façade using automation.

Comparison of Anchor points required for a single module of 4- star vs 6-star pattern

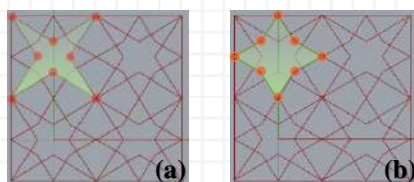


Figure 12

Figure 12 Showing the anchor points of the joints in the case of 4- point pattern.

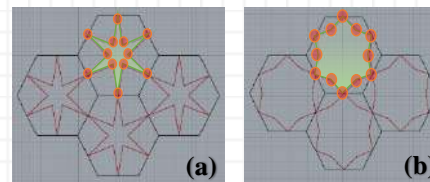


Figure 13

figure12 (a) showing 8 anchor points for joinery and mechanism and figure12 (b) showing 8 anchor points for joinery and mechanism.

Figure 13 Showing the anchor points of the joints in the case of 6- point Star pattern Image 13 (a) showing 12 anchor points for joinery and mechanism and image 13 (b) showing 12 anchor points for joinery and mechanism.

The 4-point star pattern in Figure 12 requires 8 fixed connections per unit and is less costly than the 6-star pattern when using rivets or bolts for simple mechanisms. The 6-point star pattern in Figure 13 requires 12 anchor connections per unit and is more costly than the 4-point star pattern when using rivets or bolts for simple mechanisms. For façades over 30 feet high, a 4-point star pattern generated repeat is more practical and easier for technicians to install on site in less time. The focus is now on generating his four-point pattern using mechanisms with the highlighted first 3 iterations shown in Figure 10.

3.3.1 Automation techniques:

Mechanical concept	Rotation			Rotation and translation		Translation	
Architectural type	Swivel alternately	Rotation	Flap	Fold	Scissor-fold	Slide parallel	Slide vertically
Simple movements of surfaces							
Horizontal							
Vertical							
Level							

Figure14 Movements of rigid building elements (AL-MASRANI, Salwa M. and AL-OBAIDI, Karam (2019))

Mechanical Components: Mechanical studies deal with the kinematic and kinematic design of devices,

based on the concept of architecture representing moving elements as a whole at the macro level. Schaeffer and Vogt found that moving elements consist of rigid bodies connected by hinge joints. Complex motion chains occur at hinge joints to create motion. In many cases, the movement of architectural elements in space differs from the continuous geometric movement that occurs at the level of detail. Actuators, commonly represents as valves or motors, are responsible for directly initiating processes. Different types of actuators can be used to move shading elements based on multiple aspects such as: Motion Type of movement, degree of freedom, size and weight of shading elements and covered area of the facade. Various examples of commonly used actuators are available. Linear actuators for movable slats and slat adjustment, heavy rack and pinion drives for large large façade areas, and linear actuator arms for folding mechanism.

In the case of application to the 4-point star pattern for façade we need to work on the joinery. For both mechanisms, we see that we should choose a scissors-and-fold joint with two straight rods or links connected by a pivot joint. This place is called the "pivot". In the figure, terminal nodes that can be connected to other nodes are indicated as "hinges".

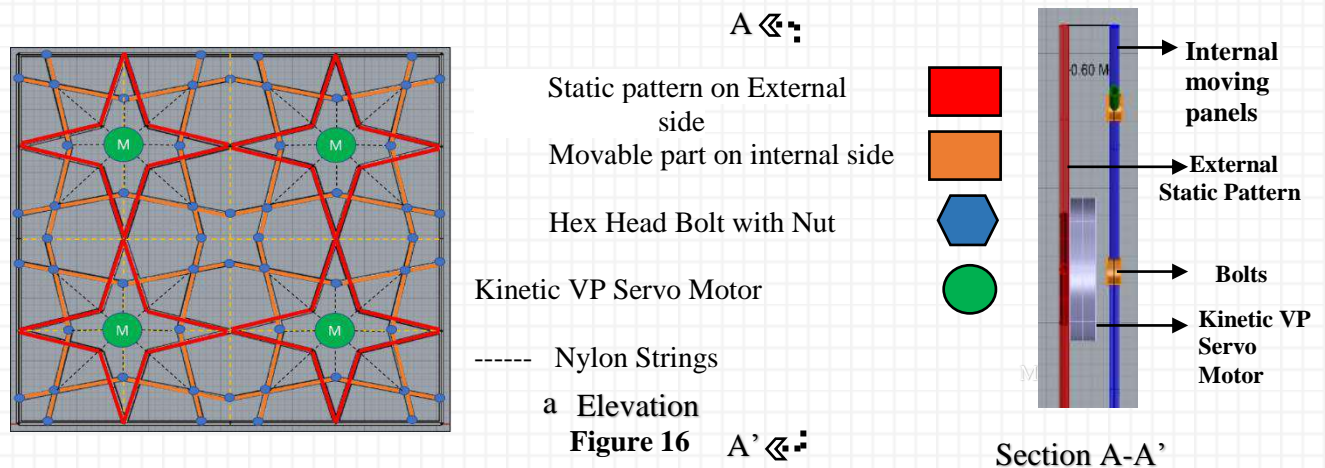
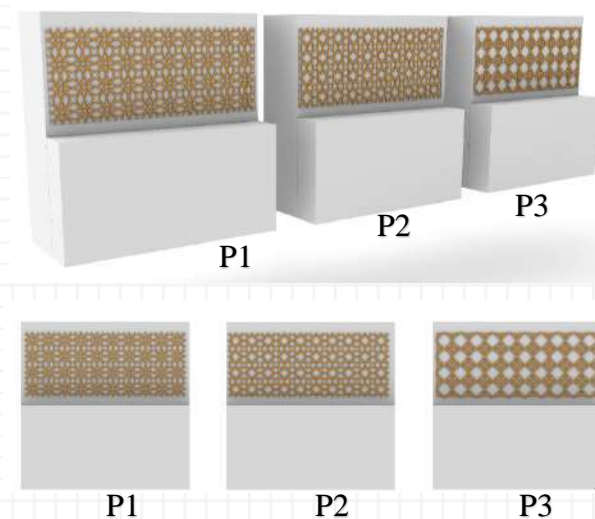


Figure 16: Showing the location of Motors along with the red part of the pattern which is static forms the external part of the module and orange part of the pattern generates mechanism. The motors and wiring connections are installed inside the box formed of 0.6M wide. Figure 16 b shows the section with layers.

For easy mechanism, we can use lightweight materials like aluminum sections, G.R.C sheets, Composite sheets, lightweight steel bars, 1/2 inch or 1-inch bolts and lock nuts. Nearly about 20 pivots and 35 hinges will be required for unit of 4 modules. A linear actuator at equal intervals with external daylight sensor will be required which will act upon the solar radiation using controller from inside the structure. An external Day light sensor can be used for automation of one pattern into 3 patterns.

3.4 : Application on the Mall at Aurangabad and Analysis.

The Mall is located in Aurangabad, Maharashtra, where two floors on front have glass façade and rest two floors have the kinetic façade designed. The three variations can be seen below on the general volume of the mall building.



Radiation Analysis on the applied Kinetic Façade is done by using grasshopper plugin known as Ladybug. The Analysis is of 10 months from 1st January to 30th October. It shows the 10 months analysis of radiation that emits on the building with the Kinetic Façade

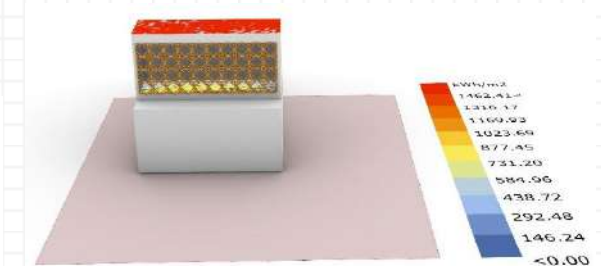


Figure 17

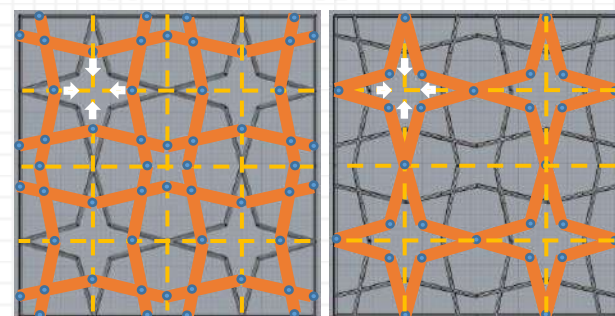


Figure 18

Figure 17 showing the application of Designed Module with three variations in perspective and elevation. The pattern changes with the application of external daylight sensor minimizing the internal radiation and also good aesthetical purpose. (P-1, P-2 & P-3 refers to Patterns) **Figure 18** showing the Radiation Analysis of the building with facade.

Where Solar Insolation is the amount of solar energy received on a unit surface over a period of time. It is expressed in units of kWh/m². In ladybug Plugin Ground reflected irradiance is crudely accounted for by means of an emissive "ground hemisphere," which is like the sky dome hemisphere and is derived from the ground reflectance that is associated with the connected _sky matrix. This means that including geometry that represents the ground surface will effectively block such crude ground reflection.

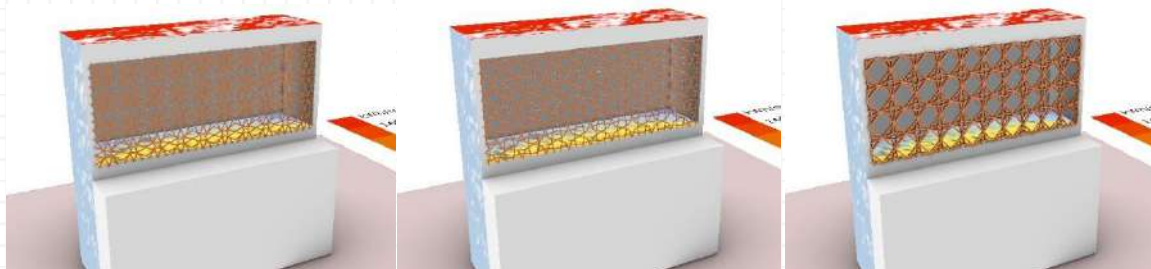


Figure 19: The above image shows the change in pattern and effect on the radiation Analysis on the internal part of the kinetic façade (P-1, P-2 & P-3 refers to Patterns)

3.5 : Conclusion and Future Scope:

This research work demonstrates a basic understanding of how Islamic geometric patterns can be transformed into many variations using parameters and the use of software in the design of kinetic façades. Three variations can be seen in the design along with mechanism. Both types of Star patterns used in the design process use the hexagonal grid as the base layout. The design focuses on screen kinetics that accommodate light and Aesthetics. The screens are generated in Rhino and Grasshopper. The interaction of these curves and the points at the vertices of the cells of the hexagonal lattice gives the dynamic movement of the screen, creating a living skin for the façade or opening.

In the Final module as seen in figure 17 used in the Façade design, the one grid remains static the screen's hexagonal cells react like a camera aperture, expanding and contracting in response to heat and light. The uses materials with expansion and contraction properties, along with a hydraulic system to control the expansion and contraction of the opening, effectively controlling the light entering the interior. This can be achieved by using a motor as the pivot for the module and a light sensor connected to the script via a computer. With examples of kinetics in architectural design at hand, kinetic façades are the new present and future of façades. It is constantly advancing, posing new challenges, tackling new problems, finding new solutions, and maximizing the use of resources to achieve harmony with the environment in which the building is located. So far, in this era of Kinetic façade design and fascination, it cannot be concluded that a perfect solution or formula has been achieved. We can look at all these existing designs in order to study them, and as models to analyze, to find out which approach best works for user comfort along with the environmental context it was placed in, and the results that these projects have in terms of optimization and energy efficiency which is important.

It can be concluded from these investigations that if further research and design exercises are performed using various geometrical patterns, unlimited solutions and screen forms can be achieved. The single module taken from a conventional screen can be the basic pattern generator and transformation in a parametric design for a screen or skin of facade or the facade itself. The numerous computer-generated solutions and options have opened a gateway for further explorations in the field of design, which undoubtedly leaves us more inquisitive. The investigations carried out in this research are significant in terms of the potential use of screens in modern architectural practices in responsive facades, using parametric patterns.

As in we are in the Era of Digitalization and smart techniques that are in the process of utilizing in the building forms and elements, there is a lot of scope for the researchers to explore more on geometry regarding the Islamic geometry patterns and how it works with Mechanism. The Sunshade devices, Temperature control inside the building can be automated using different methods and various

mechanism techniques. The research can be carried forward and explore more iterations for Islamic Star patterned Geometry in case of 6,7,9,12 etc. The research paper analysis the basic automation technique that can be applied . more types and variations can be explored by the researchers with respect to scope in the future .

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Techniques of glazing facades as innovative material and best possible alternatives of glass for hot and dry region: Case of Rajasthan, India.

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Abstract: Facade system, as one of the most complex elements of building are largely responsible for both an

energy performance and overall aesthetic qualities of building. With day-to-day innovation in materials and modern technologies, various different materials other than glass are available which can be used for building façade. This research is about to study innovative materials as an alternative for glass which will be suitable for hot and dry region. The importance of the study is to make the data available for the end users about the application to ensure the comfortable indoor environment within buildings. In this paper analytical research method has been used. The systematic literature review has been explored through internet and secondary data from relevant published academic journals articles and research papers. For the comparison study includes the effect of the glass or as well as effective shading system which respond to the solar radiation of that region. It also emphasizes on the alternatives for glass design and installation methods that expresses architectural identity and culture of the country.

Keywords: Glass façade, Thermal comfort, Hot and dry zone.

I. Introduction & Background of study

Facades play an important role in the quality of building. It forms barrier between internal spaces and external climate, influencing comfort and energy efficiency. The image of the building and users is reflected through design of façade.

The construction industry in the hot and dry zones on India is one of the main sectors especially, after the trend towards building new cities in these areas such as Gujrat, Rajasthan. Cities in India flourishes with glass facades in many office buildings, residential towers, hotels and others. In this case it is very important to use proper material and installation techniques for facade of tall buildings because not only they affect cost of building but also become key stone in selection of structural system of building. Along with this, façade of building should respond to its surroundings and hence designing façade for a building becomes an important aspect.

This paper aims to study the techniques of glazing facades as innovative materials and best possible alternative of glass for hot and dry region to ensure the sustainability of the buildings and taking into account its use in an appropriate manner expressing the architectural identity of the country and appropriate materials use in hot and dry region. The importance of the study is to make the data available for the end users about the application to ensure the comfortable indoor environment

within buildings.



I : Technological building advances in building glazing facades materials and techniques.

2.1. Ethylene Tetrafluoro Ethylene (ETFE)

Ethylene tetrafluoro ethylene, commonly known as ETFE is a fluoropolymer material. ETFE is a plastic derivative that is frequently used as a building material in the form of ETFE membranes. The material is characterized by high light and UV transmittance, temperature resistance and very low weight. ETFE film is a hundred times lighter than glass and allows more sunlight to pass through. As a result, it is often used for the construction of light-transmissive roofs. ETFE film is highly flame retardant and has a melting point of 270°C. This, together with the material's self-cleaning qualities, ensures that ETFE membranes can be used in a wide range of applications. The self-cleaning function is provided by the lotus effect: The special surface structure ensures that wind and rain are sufficient to remove dirt from the ETFE skin. In addition, the copolymer is fully recyclable and available in more than 40 colours. This comes as large sheets coated with Teflon. There is a steady increase of ETFE usage in the building industry due to its built-in properties and adaptability. ETFE is a low-maintenance, recyclable and extremely lightweight material when compared to glass. ETFE has a long life of over 50 years as it is resistant to degradation by sunlight, ultraviolet (UV) light, atmospheric pollution, etc. Depending on the specific requirements it can be manufactured as single, double or triple-ply with air fillings. In single ply-form its thermal and acoustic performance is very poor and so is not suitable for façade applications. However, in the two or three-ply forms it has very good thermal properties, because the air trapped between the layers acts as an insulator [1]. ETFE is fire resistant and can be easily repaired when damaged. ETFE is 100% recyclable and self-cleaning. It is a very sustainable material with low levels of CO₂ emissions due to its lightweight at the same time its carbon footprints believed to be 80 times lesser than other transparent building materials such as glass. ETFE can admit lighter than glass, thereby reducing the energy costs by 30%. One prominent example of ETFE facade is the Beijing National Aquatics Centre having an area of 100,000 m²



Figure 1. ETFE in facade of Beijing National Aquatics Center, Beijing, China

2.2. Self-Cleaning Glass

The self-cleaning coating on glass is divided into two categories i.e., hydrophobic and hydrophilic. These two types of coating both clean themselves through the action of water, the former by rolling droplets and the latter by sheeting water that carries away dirt.

Hydrophilic coatings based on titanium dioxide can chemically break down absorbed dirt in sunlight. Self-cleaning glass consists of a thin layer of photo-catalysts on its surface, which are compounds that accelerate a chemical reaction using the UV bands of sunlight. The commonly used photo-catalyst is titanium dioxide.

The self-cleaning process of glass happens in two stages: The photo-catalyst stage when the glass is exposed to light; it breaks down the organic dirt particles and the hydrophilic stage when the rain washes the loose particles from the glass. This reduces the maintenance costs of the building and helps keep the glass clean.



**Figure 2 shows The Elbphilharmonie Concert Hall
with self-cleaning glass, Hamburg, Germany.**

2.3. Thermo-Chromic Glass

Thermochromic windows are the most advanced, yet simple, dynamic facade window technology available and are quickly growing in popularity and being installed in many commercial, retail and residential buildings throughout the world. The thermochromic glass simply uses heat from direct sunlight to tint the windows when necessary. The more direct and intense the sunlight is on the glass the darker it will become (Figure 4). This allows the windows to drastically reduce the heat load coming

into the building and because the glass transmission adapts continuously over a range of temperatures, a natural balance and maximum use of daylighting is achieved. By design, thermochromic windows help reduce glare, fading and noise, and increase safety.

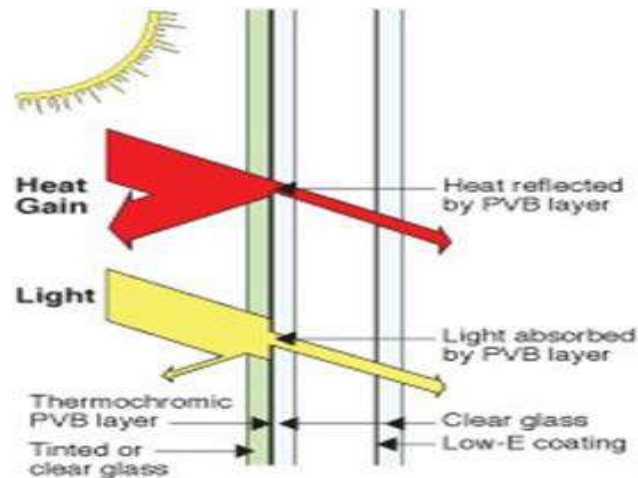


Figure 3 : Heat reflectance and light absorption through the Thermochromic film.

2.4. Fritted Glass

Fritted glass has computer-controlled patterns printed on the surface. Fritted glass has application ranging from reducing solar gain; avoid glare; or simply creating a pattern, also, giving better safety and privacy. The Ryerson University student Centre at Toronto, Canada is a light, transparent designed to be energy- efficient and is an excellent example for its use of fritted glass making it resemble an ice crystal. It has a high-performance facade which is triple glazed, low e-coated, fritted, and shingled (Figure 4).



Figure 4. Fritted glass on the facade of Ryerson University student Centre, Toronto, Canada

2.5. FRP Composites

Fiber Reinforced Polymer (FRP) composites represents a family of materials combining fibers and polymers to offer excellent mechanical, thermal and insulation properties. Within the frame of engineering applications in buildings and infrastructures, FRP composites have been extensively investigated, especially in the last decade. FRP composites represent a relatively novel construction

solution with several intrinsic advantageous properties, such as high strength and stiffness, reduced mass, low thermal conductivity, high corrosion and weather resistance, durability, but also the implicit feature of offsite fabrication, modular construction capacity and possibility to mould complex forms with special finishes and effects [5]. One of the best examples of FRP composite facade is the Ravel Residence at Amsterdam, The Netherlands (Figure 5). The Ravel Residence is a versatile, sustainable campus for 800 students, designed to have a positive impact on the urban environment



Figure 5-. FRP panels on the facade of Ravel Residence, Student housing

2.6. Polycarbonate Panels

Polycarbonate panels are transparent polycarbonate elements meeting the highest requirements and provide many possibilities of application. Polycarbonate panels are produced in several thicknesses: 40, 50 and 60 mm, in transparent, translucent, brown (smoky) colors. For larger quantities, they can be ordered in any colour. For 50mm and 60mm thick panels, an aluminum profile system with an integrated thermal break that minimizes heat loss - so-called “warm” profiles - has been developed. A huge advantage of polycarbonate panels is the simplicity of their installation. The comfort of use is also vital (easy maintenance) as well as no thermal bridges at panel joints. In walls of polycarbonate panels, hopper windows can be fitted without additional supporting structures [6].



Figure 6. Polycarbonate Panels on the Facade of Warsaw art studio

II. Research Methodology

In this paper analytical research method has been used. The systematic literature review has been explored through internet and secondary data from relevant published academic literature from journals, articles and research paper and the observations to work for qualitative analysis conducted for different types of innovative materials and techniques have been used in the facades of contemporary high buildings around the world.

III. Results & Discussion

IV. Comparison with other materials

Based on secondary data available from various sources we can compare all conventional materials which are generally used for façade of building

Property	Laminated Safety glass 13.5 mm	Insulated Double glass 24 mm	PVC	Polycarbonate 16 mm wall	PTFE	ETFE
Life span	10-15 yr	10 years	15+ years	15+ years	30+ Years	30+ years
Self-weight	36 kg/m ²	30 kg/m ²	1 kg/m ²	3.3 kg/m ²	1 kg/m ²	1 kg/m ²
Panel size	3.2 x 6 m	3.2 x 6 m	Up to 14 m	1.4 x 12 m	Up to 4 m	10 x 10 m
Weight of support	55-75 kg/m ²	55-75 kg/m ²	30-40 kg/m ²	35-45 kg/m ²	30-40 kg/m ²	25-30 kg/m ²
U value	5.5 W/m ² K	2 W/m ² K	4.6 W/m ² K	2.3 W/m ² K	4.6 W/m ² K	1.18K/m ² K
Light gain	85 %	76 %	10-15%	63 %	15-20%	0-90%
Heat gain	0.69	0.67	0.18	0.53	0.18	0.0 - 0.8
Noise gain	moderate	low	high	moderate	high	high
Fire resistance	Non combustible	Non combustible	Non combustible	Low	Non combustible	Non combustible
Smoke removal	n/a	n/a	n/a	n/a	n/a	available
External cleaning	Regular manual	Regular manual	Regular manual	Regular manual	Self but unsightly	Self-cleaning
Repair	Removal of entire panel	Removal of entire panel	Patch repair	n/a	n/a	On spot patch repair
Grass growth	Good	Good	Poor	Poor	Moderate	Excellent
Ease of installation	Moderate	Moderate	Good	Moderate	Good	Excellent
Environmental credentials	Moderate	Moderate	Good	Good	Moderate	Excellent

.(International Journal of Scientific and Research Publications, Volume 7, Issue 10, October 2017 ISSN 2250-3153)

Following are the best possible alternative materials of glass for glazing façade in hot and dry region and listed as per their best efficiency.

1.ETFE

Due to light weight of material it is easy to handle, transport, erect on position and even fix it. ETFE have a long-life span thus no need to replace unless it is seriously damage, and even if need so one can replace entire panel on the spot. Thus, no disturbance to surrounding framing members. Cost of construction can be controlled by replacing glass facade with ETFE. Further ETFE have very high melting point and even at burning it does not produce droplets. It can hold fire up to certain temperature after which the air cushion breaks up, evaluating smoke generated by fire outside, and thus helps to save human life to great extend [1]. Self-cleaning property of material reduces frequency of building maintenance. Since light transmission through ETFE is good, growth of grass in landscape area inside building is excellent. When we consider all these points, surely ETFE have many advantages over traditional building facade material.

2.Thermo cleaning glass

The thermochromic glass simply uses heat from direct sunlight to tint the windows when necessary. The more direct and intense the sunlight is on the glass the darker it will become (Figure 4). This allows the windows to drastically reduce the heat load coming into the building and because the glass transmission adapts continuously over a range of temperatures, a natural balance and maximum use of daylighting is achieved.

3.FRP Composites

FRP is light in weight and helps in cutting expenses on labour and installation. FRP increases construction speed that further reduces environmental impacts.

Fibreglass composite materials are not just durable; they also have high strength as compared to traditional materials. Users can expect less material usage to attain better or similar performance compared to conventional materials which result in lessened resource use as well as waste production.

FRP has great potential in further maximising the longevity of existing as well as new and structures that can resist the harsh effects of weathering, degradation, and aging in severe environments.

FRP composite materials are extremely resistant to corrosion and rot. Besides these, they present a longer and yet more efficient service life. FRP based products hardly require an energy-intensive replacement nor much maintenance.

V. Limitations

This research is entirely based on secondary data source and no actual experiment was carried out during research period. This is just a theoretical analysis.

VI. CONCLUSION

Facade system, as one of the most complex elements of building are largely responsible for both an energy performance and overall aesthetic qualities of building. With day-to-day innovation in materials and modern technologies, various different materials other than glass are available which can be used for building façade. This research was about to study innovative materials as an alternative

for glass which will be suitable for hot and dry region.

For the comparison study includes the effect of the glass or as well as effective shading system which respond to the solar radiation of that region. It also

emphasizes on the alternatives for glass design and installation methods that expresses architectural identity and culture of the country. A new paradigm of facades has emerged due to technological advancement in the material science and prefabrication which interact with the external environment by the integration of new technologies. Some of these facades have intelligent control system, while some use passive technologies such as solar shading, ventilation and thermal mass. Some of these materials and design strategies for facade can help in reducing the cooling and heating load on HVAC systems there by reducing

the energy consumption of the structure. Future advanced facade design research is needed in order to understand sustainable design in a more comprehensive way and apply its principles to tall buildings and make efficient data as best possible alternative for glass facades available to end users.

ACKNOWLEDGEMENT

I would like to express my deep sense of gratitude from the bottom of my heart to my guide Prof. Shubhashree Upasani, and library staff during this process of research, guidance helped me to complete the study of the topic the techniques of glazing facades as innovative materials and best possible alternative of glass for hot and dry region

, for their valuable guidance, inspiration and encouragement. Their keen and indefatigable indulgence in this work helped me to reach an irreproachable destination.

I'd also like to acknowledge the help of my classmates for their useful suggestions and the discussions about the topics and the references which helped me to successfully complete my research.

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INFLUENCES OF URBAN FORM ON URBAN SEGREGATION

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Abstract: Cities today all around the globe are continually changing and so is the urban form. New structures are added in the urban fabric, streets are redesigned, and newly emerging forms transform the urban environment of the city. All these changes in one way or the other influence the spatial relations within the city. Developing Indian metro cities are witnessing growth in peri-urban areas where development in patches leads to socio-spatial fragmentation. The city can be visualized as a large collection of buildings linked by space or a system of human activities linked by interaction. The form of the urban environment and the lives we live in cities are interdependent, thus spatial form needs to be understood as a contributing factor in forming the patterns of integration and segregation in cities. Today cities mainly follow the principles of a highly zoned urban space, which at a larger scale can give rise to the fragmentation of the city into many mono-functional subparts. Every time a new piece of the urban fabric is created, or an existing piece is patched up and reworked, it may add to the value of the real estate but subtracts from the socio-cultural life of the urban area. Segregation in space influences different aspects such as movement flows and patterns, co-presence in public space, accessibility etc. For this research, literature and case examples of neighbourhoods were explored and analyzed to understand how urban fragmentation influences certain socio-spatial factors in cities and how urban design principles can pave the way for less segregated neighbourhoods. The research methodology was centered on evaluating how different scales of experiences and uses of urban form affect segregation. Furthermore, the study also presents various possibilities of integration in urban public space without being overpowered by urban form and morphology.

Keywords: Urban form, socio-spatial segregation, peri-urban development.

1. Introduction:

1.1 Emerging Urban Form:

The emerging city form in peri-urban areas can be observed as business parks, IT corridors, enclaved development, commerce zones, high rise townships, urban redevelopment projects etc. that influence various social and spatial aspects. New structures are added in the urban fabric which influences movement flows, networks, interaction levels, the notion of safety, and use of space by individuals. Segregation at a neighbourhood level affects urban permeability, social interactions, opportunities for meeting and human experiences. Spatial urban formation of cities should be understood and analyzed as it forms the patterns of integration and segregation. To understand how changes in urban form influence aspects related to segregation, it is important to relate physical city to the social city. Due to the growing population, demand for housing and infrastructure, and in-migration; cities are sprawling in the peri-urban areas of cities. Due to the scarcity of land in cities, the pressure on infrastructure in peri-urban areas is likely to increase in the coming years. Segregation in space affects different aspects of life and influences movement flows and patterns, co-presence in public space, permeability, open space structures and accessibility.

1. 2 Society and Space:

Society and space are related and are mutually dependent. Cities develop and display connections which are influenced by spatial and social structures. Traditional cities with urban blocks and modern planning with estates show drastic differences in terms of urban form and resultant urban life. New urban layouts, the structure of public spaces, the shape of built form influences people's daily movements and use of space. With enlarging private spheres, modern life in big cities affects individuals, society, and social life at large. Individual spaces and segregated spaces have taken up over community spaces. The physical attributes and elements of cities are linked with social and spatial impacts on the larger urban fabric. Introvert development influences aspects like accessibility, movement patterns, surveillance, and interaction levels. Neighbourhoods which were initially connected by street networks, open spaces, and a larger public realm are now disconnected, disjoined and have individual identities.

2. Objectives of the Research :

- The objective of the research is to identify the physical and social aspects in Indian neighbourhoods that lead to spatial and social segregation.
- To understand the relationship between urban spaces and the individuals engaging in it.
- To devise strategies that can overcome fragmentation in the city; and that can enhance everyday life and human experiences that are fostered in open urban spaces.

3. Research Methodology:

For this research, literature was reviewed from various books, research papers, published journals to understand the relation between urban morphology and its socio-spatial aspects. Live case studies were documented and analyzed to understand various factors affecting everyday urban life and activities. Physical survey was carried out to understand the role of various urban design and planning parameters in everyday life. The research findings helped in accessing various issues related to segregation and integration in urban spaces.

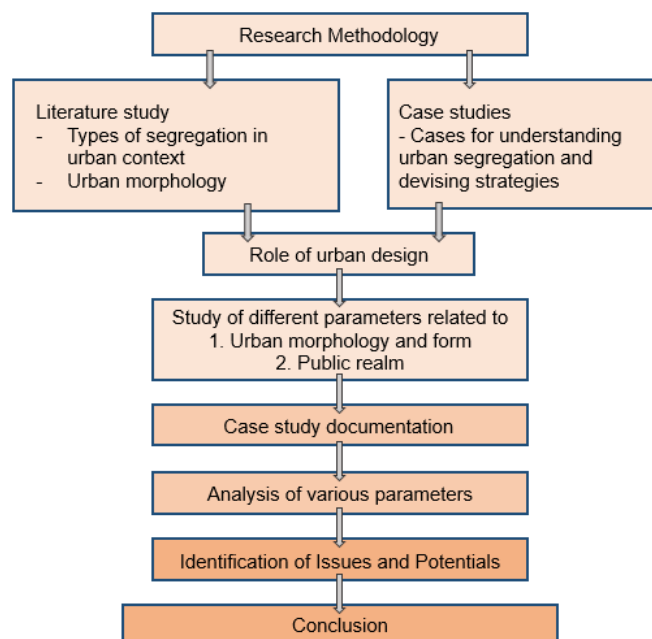


Figure 1: Research Methodology

4. Literature Review:

The concept of segregation is a complex multi-dimensional issue that renders it difficult to express by means of one theory or discipline alone. Spatial segregation has very often been equated with social exclusion, (Vaughan and Arbacci, 2011) whereas, in reality, fragmentation in cities influences social behaviour and relations of individuals.

4.1 Types of Segregation in Urban Context:

Segregation in cities can be identified on the basis of various characteristics and criteria. Spatial segregation depends on the structure and organization of cities in terms of urban form and development. Spatial segregation of the poor occurs due to informal settlements in cities. Income-based segregation results in creating distinct zones where people from different economic backgrounds often live in segregated neighbourhoods. Ethnic segregation is observed by the formation of ghettos with particular culture, traditions and lifestyle patterns where different ethnicities are separated into neighbourhoods. Voluntary segregation is seen due to the proliferation of new gated enclaves and the emergence of present-day urban form in most of the cities. This trend seems to have several motivations, including both supply and demand factors. Fragmentation can also be seen due to ecological and geographical factors. Some areas are isolated and have low accessibility from other neighbourhoods, where potential interaction between individuals is limited.

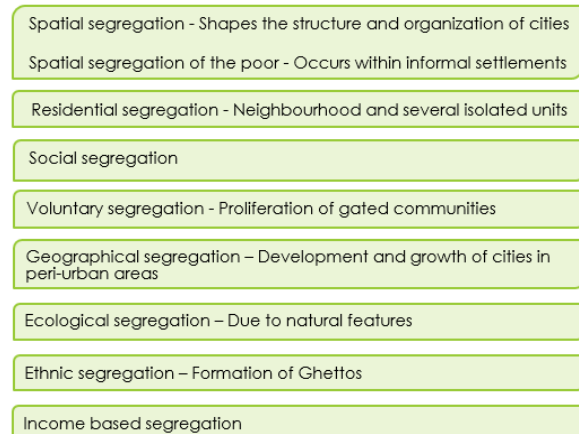


Figure 2: Types of Segregation

A spatial barrier in the modern city has been distance. With the development of transport, it has allowed individuals to move away from the city, segregating and stretching the city into detached neighbourhoods and districts. Some urban layouts separate people from each other, and the contact between neighbours is made strenuous due to spatial relations between buildings, entrances, streets, and neighbourhoods.

4.2 Influences of Morphology on Urban Life:

The elements of contemporary urban life are determined by how urban space is produced, for what reason and by whom. The relation between urban space and the individual engaging in it is a crucial issue in today's cities, which merely looks like an aesthetic or economic contrast. Layout and organization of urban spaces and forms either strengthens or weakens urban features within cities. This research looks at the possibility of integration in urban public space without being overpowered by urban form and morphology. The deeper question lies if urbanism should facilitate the growing socio-spatial segregation, or social mixing and integration be encouraged? It is necessary to analyze integration elements that contribute to a less segregated city and mitigates the hindrance of urban form in everyday life and activities.

4.3 Need for Urban Integration:

Cities are living ecosystems where buildings, streets and neighbourhoods decide how people interact with them. Each element of the city helps in understanding how a precinct functions spatially and socially. A strong and active public realm is essential to promote social interaction, boost the local

economy, and nurture a vibrant environment in the neighbourhood. There is a need to find alternative ways to design enclaved developments, intermediate, transitional, and public spaces which allows for a greater connection between built form and public realm. Public spaces are a basic need for cities and can act as facilitators to combat the spatial segregation concerns in cities. It is necessary to promote mixed-use neighbourhoods and public spaces which can confront social fragmentation and exclusion by creating integrative and vibrant urban areas.

5. Case Studies:

Live case studies were conducted in neighbourhoods on Pune, Maharashtra. Pune city has witnessed rapid urbanization in the past few decades which has resulted in the emergence of a new urban form. The precincts were selected on the basis of settlement pattern; one being an enclaved precinct developed in the past few years and the other being a mixed use neighbourhood near the core area of the city.

5.1 Hadapsar, Pune:

The need for new urban areas has resulted in the creation of the Magarpatta Township. It is a 600 acre privately owned township located in Hadapsar, Pune. It is a city within a city comprising of residential towers, commercial establishments, gyms, schools, IT hubs, shopping areas, and gardens.

It is designed as a walled township on the concept of 'Walk to Work, School, Shop' and 'Live-Work-play'. It is a gated development with restricted access only to certain areas, while rest being accessible to the general public. The hierarchy of recreational spaces is situated at different accessible locations. The destination centre is a commercial complex that is bustling with activities due to its human scale, accessibility, seating areas, eating outlets, and economic activities.

Green sidewalks, plantations and benches alongside the roads make walking and social interaction pleasurable. Wide roads, traffic islands, cycling tracks, walkways and block parks contribute to an active public realm. Bicycle rental stands are located every few hundred meters inside the township. Continuous and safe bicycle tracks make cycling a delightful experience. Due to semi-restricted access, this township does not give a fortified feeling as against the other gated communities and has public spaces that can be accessed by all. The urban form is inviting and tends to the human scale thus creating spaces for social integration. Many other enclaved precincts in the vicinity are secluded from the larger neighborhood thus creating segregated spaces.

5.2 Kothrud, Pune:

A study area of approximately 1 sq. km located in Kothrud, Pune was selected to assess the effects of urban form on everyday urban life. This area has developed commercial and residential real estate rapidly since the 1980s. It was the developing suburban area with a boom in commercial establishments, housing, IT offices, educational institutes and recreational areas. The elements of inquiry for the study regarding urban form are:

- Social life and interaction – Elements promoting or hindering social interaction
- Segregation and integration in publicly accessed open spaces.
- Edge interface – active and inactive edges
- Everyday spaces used by people to socialize, work play and shop
- Use of streets and squares
- Safety and surveillance



Figure 3: Mapping of Building Typologies

Different interfaces along the streets create a positive or negative street edge. In this precinct, some gated developments have commercial edges which contribute to the vibrant street life thus imparting social interaction among the citizens. On the other hand, some urban forms have fortified themselves against the outside activities with high walls, thus discouraging the presence of interaction.

6. Conclusions:

It can be concluded that fragmentation in urban areas is more than just a spatial concern because it has social-cultural effects on people's behaviour patterns, user experiences, levels of interaction, perceptions of safety, and how they use space. Prioritizing placemaking, accessibility, outdoor activities, walkability, and surroundings that encourage safety and surveillance can help accomplish integration in space.

Developing Indian metro cities are witnessing growth in peri-urban areas where development in patches leads to socio-spatial fragmentation. Urban design guidelines and strategies should be included in policies and frameworks to regulate the upcoming urban form. Initiatives for integrating fragmented spaces such as creating public urban spaces and vibrant transitional spaces should be taken into consideration. The presence of inclusive and open urban environments, which offer a diverse range of opportunities, favours the role of the city as a mode of integration. Strategies from the user perspective should be focused as spaces cannot be devoid of people. Addition of a completely new form influences various aspects in cities. Thus there is a need to guide such developments to ensure cohesive and holistic urban environments. It can also be concluded that a greater presence of inclusive spaces and environments that offer a diverse range of opportunities, function as integration tools.

Cities should be understood from a perspective that neighbourhoods, buildings and people are spatially and socially related through the street network, accessible open spaces in the neighbourhood, temporal activities providing opportunities for interaction. Focus on public spaces is the way forward as it provides a potential for people to share spaces and hence share practices and cultures.

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HEALTH & WELL-BEING IN SUSTAINABILITY FRAMEWORKS:

A Comparison of *IGBC's Health & Well-Being Framework* with *Living Building Challenge*, *WELL v2* and *Fitwel*

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Abstract: Peri-urban architecture follows urban architectural developments while reconciling with rural architectural concerns. SDG 3 of the United Nations' *2030 Agenda for Sustainable Development* relates to Good Health & Well-being of people. There are specific frameworks developed for the health and well-being of building occupants. Further, some sustainability frameworks have also included health and wellbeing within their frameworks.

India has two frameworks for achieving health and well-being in buildings. The *Indian Green Building Council's Health & Well-being Rating for Occupants (IGBC H & W)* and the *Green Rating for Integrated Habitats Assessment* developed by *The Energy Resource Institute*.

This paper examines *IGBC's Health & Well-being* framework with relation to the *WELL Building Standard* of the *International WELL Building Institute*, *Fitwel Building Standard* developed by the *Center for Disease Control* of the United States of America, and the *Living Building Challenge* developed by the *International Living Future Institute*.

It is seen that *IGBC H & W* is modelled on the *WELL v2* framework and uses a similar approach in addressing air, water, thermal comfort, ergonomics, sound (acoustical comfort), visual comfort and more.

However, *IGBC H & W* claims to represent an Indian approach by philosophically interpreting the connection between the five elements of Earth, Water, Fire, Air and Ether to human senses which it calls consciousness, and lists human organs responsible for specific perceptions related to those organs.

In practical terms, *IGBC H & W* includes criteria that are specifically applicable to the Indian context like spiritual well-being, cultural activities, service to society and women's safety.

In the end, it is found that *IGBC H & W* can be improved if it includes some criteria from the other frameworks like diversity and inclusion, public awareness/education, beauty, green building certification, and carbon reduction. This will also help in creating better living and working conditions in peri-urban areas benefiting populations in these zones.

Keywords: Health & Well-being, *IGBC*, *IGBC H & W*, *Living Building Challenge*, *WELLv2*, *Fitwel*

1. Introduction

Peri-urban architecture follows urban architectural developments while reconciling with rural architectural concerns. SDG 3 of the *United Nations' 2030 Agenda for Sustainable Development* (<https://sdgs.un.org/goals>, n.d.) relates to Good Health & Well-being of people. India has two frameworks for achieving health and well-being in buildings. The *Indian Green Building Council's Health & Well-being Rating for Occupants* (IGBC H & W) and the *Green Rating for Integrated Habitats Assessment* developed by *The Energy Resource Institute*.

Internationally, also, a number of health and well-being frameworks emerged in the last few years. Two among them are the *WELL v2 Building Standard* (<https://www.wellcertified.com/>, n.d.) and the *Fitwel Building Standard* (<https://www.Fitwel.org/>, n.d.). Further, existing sustainability frameworks like the *Living Building Challenge* among others, have also included health and wellbeing criteria.

How well does an Indian framework compare with existing international frameworks? Are there any criteria that need to be updated or included in *IGBC's Health & Well-being* framework? Does *IGBC's Health & Well-being* framework bring out any deficiencies in the other international frameworks under study in this paper? These are some of the questions that this paper seeks to answer.

1.1 Scope and Limitations

This study limits itself to the following scope:

1. Only criteria related to new constructions of workspaces are studied.
2. The documentation, process, method, point system, cost, schedules, and time required for processing and certification are not considered.
3. The study does not consider criteria applicable during construction or before occupancy, nor does it consider criteria for workers during construction.
4. This study limits itself only to comparing the qualifying criteria of the frameworks.

Methodology

In this paper, I study each criteria of *Indian Green Building Council's Health & Well-being Rating for Occupants* (IGBC H & W) with reference to similar criteria of the other international health and well-being frameworks of *WELL v2*, *Fitwel* and the health and well-being criteria of *Living Building Challenge*. Due to space constraints, I only provide an overview of whether or not the intent is similar. At the end, the results of the study are discussed and conclusions are drawn.

2. WELL v2 Building Standard (<https://www.wellcertified.com/>, n.d.)

Conceptualized and initiated by the *International WELL Building Institute*, the *WELL Building Standard* for health and well-being claims to have been developed over 10 years backed by the latest scientific research.

2.1 Concepts of WELL v2

Projects have to fulfil criteria across 10 concepts to be eligible for a certification. Within the 10 concepts are 24 preconditions which are necessary to be achieved, and 98 possible optimizations. The 10 concepts are:

1. Air
2. Water
3. Nourishment
4. Light
5. Movement
6. Thermal Comfort
7. Sound
8. Materials
9. Mind
10. Community
11. Innovation

3. *Fitwel* Certification System (<https://www.Fitwel.org/>, n.d.)

Created by the *US Centers for Disease Control* (CDC) and *US General Services Administration*, *Fitwel* is said to be generated by expert analysis of more than 5600 academic research studies. The certification encourages design strategies and policies in buildings and sites for lowering stress levels, reducing injury and mitigating risk of disease with the aim of increasing productivity.

3.1 *Fitwel* Strategies

Fitwel has a total of 55 strategies under 12 areas of intervention that address specific health behaviours and risks.

The 12 areas of intervention are listed below:

1. Location
2. Building Access
3. Outdoor Spaces
4. Entrances and Ground Floor
5. Stairs
6. Indoor Environments
7. Workspaces and Dwellings
8. Shared Spaces
9. Water Supply
10. Prepared Food Areas
11. Vending Machines and Snack Bars
12. Emergency Preparedness

4. *Living Building Challenge* (International Living Future Institute, 2019)

The *Living Building Challenge (LBC)* building standard is a green building framework developed by the *International Living Future Institute*. It seeks to “rapidly diminish the gap between current limits and end-game positive solutions...” (International Living Future Institute, 2019).

4.1 Petals

The *LBC* has seven performance categories which they call “Petals”. The Petals are as below:

- 1) Place
- 2) Water
- 3) Energy
- 4) Health + Happiness
- 5) Materials
- 6) Equity
- 7) Beauty

Each of these Petals has Imperatives under its domain. There are a total of 20 Imperatives. The *Living Building Challenge* certification requires meeting all the 20 Imperatives.

5. *Indian Green Building Council’s Health & Well-being Rating for Occupants* (IGBC)

Indian Green Building Council’s Health & Well-being Rating for Occupants (IGBC-H & W) takes a ‘Whole Body Mind’ approach toward health and well-being of occupants. IGBC-H & W claims that people perceive a built environment through their five senses, viz. smell, taste, sight, touch and sound. It claims that five elements of nature, viz. earth, fire, air, water, and ether, which make up the built environment affect physical, emotional and intellectual, and social well-being of building users. It seeks to improve these features to enhance health and well-being of occupants.

5.1 IGBC Health and Well-Being Rating

IGBC H & W lists its criteria under the four main headings below:

- 1) Physical Well-Being
- 2) Emotional Well-Being
- 3) Social Well-Being
- 4) Innovation and Design

6. Comparison of the *IGBC H & W* with *WELL v2*, *Fitwel* and The *Living Building Challenge*

I consider the ‘New Building’ category under *IGBC H & W* for commercial buildings. While *LBC* does not categorize criteria for building typologies, for *WELL v2*, I use the ‘Owner Occupied’ (*WELL v2* Concepts and Features, 2022) project type. For *Fitwel*, I use the ‘Multi-Tenant Whole Building’

(*Fitwel* v2.1 Scorecard Worksheet - Multi-Tenant Whole Building, 2021) under New Constructions category.

IGBC H & W has 100 credits, while *LBC* has 20 Imperatives including 10 Core Imperatives under seven Petals. *WELL*v2 has 213 such parts within 10 Concepts and one concept for innovation. *Fitwel* has 73 Strategies under its 11 sections for achieving health and happiness. These numbers indicate the detail to which each criterion has been specified.

In *LBC*, only the Petal titled “Health + Happiness” addresses human health in a building. Below, I discuss each of *IGBC H & W*’s requirements with respect to *LBC*, *WELL* v2 and *Fitwel*.

1) **Physical Well-Being**

A) **Indoor Air Quality**

a) **IAQ Mandatory Requirement 1: Tobacco Smoke Control**

This requirement aims to avoid exposure of non-smokers to the adverse effects of passive smoking.

- i) ‘No Smoking’ Signage at main entrance and prominent locations
WELL v2 covers this criterion under its Smoke-Free Environment feature where smoking indoors and outdoors is prohibited.
Fitwel covers this criterion under its Tobacco- and Smoke-Free Signage to be placed at all entrances and outdoor areas.
LBC also prohibits smoking within and within 25 feet of the building under its Core Imperative 9: Healthy Interior Environment.
- ii) No Smoking Policy or Isolated Smoking Zone
WELL v2 covers this criterion under its Smoke-Free Environment feature where smoking indoors and outdoors is prohibited.
Fitwel covers this criterion under its Tobacco- and Smoke-Free Environment strategies.
LBC also prohibits smoking within and within 25 feet of the building under its Core Imperative 9: Healthy Interior Environment.
All three frameworks do not make provision for an isolated smoking zone.

b) **IAQ Mandatory Requirement 2: Fresh Air Ventilation**

This mandatory requirement seeks to provide fresh air within the building.

- i) Mechanically Ventilated Spaces
This criterion calls for fresh air input in mechanically ventilated buildings at the rate specified by the National Building Code 2016.
WELL v2 ensures adequate ventilation and improving ventilation effectiveness under ASHREA 62.1-2010.
Fitwel also covers this criterion under its Indoor Enhanced Air Quality Policy.
LBC also recommends following ASHRAE 62 or international equivalent as a standard for this criterion.
- ii) Naturally Ventilated Spaces
IGBC H & W provides for 8 % to 12 % of openable area to carpet area.
WELL v2 requires 75% of the spaces to have operable windows in its Operable Windows feature.

Fitwel also specifies ASHRAE 62.1-2019 and 62.2-2019 for its ventilation needs but does not mention operable windows.

LBC also calls for “sufficient operable windows” for providing natural ventilation.

c) **IAQ Credit 1: Monitor Indoor Air Quality**

IGBC H & W seeks to monitor indoor air quality and enhance awareness among occupants.

i) Measure, Monitor, Maintain

It specifies thresholds for Carbon Dioxide, PM 2.5, PM 10, CO, Ozone, TVOC, Sulphur Dioxide and Nitrogen Dioxide. It also mentions the frequency of monitoring for these pollutants.

WELL v2 requires a project team to measure the air parameters of PM 2.5, PM 10, TVOC, Benzene, Formaldehyde, Toluene, carbon Monoxide, Ozone, Nitrogen Dioxide. To be monitored continuously per its feature of Air Quality Monitoring and Awareness.

Fitwel specifies the parameters of PM 2.5, Carbon Dioxide, TVOC, RH, Ozone, Carbon Monoxide and formaldehyde. To be monitored to continuously show monthly averages.

LBC asks the project team to continuously monitor air quality and to develop a Healthy Indoor Environment Plan.

ii) Display

IGBC H & W seeks to display parameters monitored daily at prominent places.

WELL v2 requires display of at least three parameters mentioned above.

Fitwel requires sharing of results annually with all occupants.

LBC requires continuous monitoring and providing results one to six months after occupancy.

d) **IAQ Credit 2: Reduce Indoor Emissions**

IGBC H & W seeks to monitor and implement measures to reduce indoor emissions and microbes.

i) Measure, Monitor, Maintain

This requirement is to monitor indoor emissions and to ensure that 80% of measurements are within threshold values.

WELL v2 meets this criterion in its Microbe and Mold Control Feature.

Fitwel also meets this criterion in its Break Areas Cleaning Protocol and requires the creation of a cleaning policy.

LBC also requires a project team to prepare a Healthy Indoor Environment Plan detailing protocols for cleaning.

ii) Low-Emitting Materials

This requirement is to encourage use of materials and systems with low emissions.

WELL v2 meets this criterion in its criteria that limits VOCs of wet-applied products and restrict VOC emission from furniture, architectural and interior products.

Fitwel meets this criterion in *Fitwel Indoor Air Quality Policy Standard*.

LBC also compliance with CDPH Standard Method v1.1-2010 (or international equivalent) for limiting VOCs from interior building products.

iii) Minimize Indoor Pollutant Contamination

This requirement is to minimize exposure of occupants hazardous indoor and outdoor pollutants.

WELL v2 meets this criterion in its requirements of Design for Healthy Entryway systems, Improving Ventilation Effectiveness, Managing Pollution and Exhaust, Implementation of Particle Filtration, as well as its several other criteria under the concept of Air.

Fitwel meets this criterion in its criteria for Entryway Systems and Chemical Storage Ventilation as well as in its *Fitwel Indoor Air Quality Policy Standard*.

LBC also requires a project team to prepare a Healthy Indoor Environment Plan detailing protocols for cleaning and prevention of particulates and toxins.

B) Water Quality

a) WQ Mandatory Requirement 1: Access to Drinking Water

This requirement aims to provide access to adequate drinking water to occupants

i) Water Quantity

IGBC H & W requires the provision of at least 2 liters of drinking water per person per day.

WELL v2 does not mention the quantity of water that needs to be provided.

Fitwel does not specify the quantity of water to be made available per person.

LBC does not specify the quantity of water to be made available per occupant.

ii) Accessibility (Location, Distance)

IGBC H & W requires the provision of at least one water fountain per floor.

WELL v2 meets this criterion in its feature of Ensure Drinking Water Access.

Fitwel meets this criterion in its Universally Accessible Water Supply strategy.

LBC requires treating and recycling all water used on the site. It calls for availing a week's water supply for all occupants.

b) WQ Credit 1: Quality of Drinking Water

This requirement aims to ensure quality drinking water to all occupants

i) Municipal/Borewell Water or Third-Party Supply

IGBC H & W calls for water to be treated to meet the specified drinking water specifications.

WELL v2 meets the above criterion in its Assess and Maintain Drinking Water Quality feature.

Fitwel meets this criterion in its Water Quality strategy.

LBC does not call for testing water quality, but only mentions that water should be purified without using chemicals.

c) **WQ Credit 2: Quality of Recycled Water**

This requirement aims to monitor quality of recycled water to reduce risk of water-borne diseases.

i) Measure the Quality of Treated Recycled Water

IGBC H & W requires measuring the quality of treated recycled water per specifications mentioned.

WELL v2 meets this criterion in its feature that Implements Safety Plan for Non-Potable Water Capture and Reuse.

Fitwel does not mention anything about recycled water.

LBC encourages recycling water and testing it, but does not list criteria to be met for the testing.

C) **Comfort**

a) **CT Mandatory Requirement 1: Occupant Satisfaction Survey**

This requirement aims to provide ensure occupants are satisfied with the comfort conditions.

i) Occupant Satisfaction Survey

IGBC H & W requires that an occupant satisfaction survey be conducted for visual comfort, thermal comfort, acoustical comfort, olfactory comfort, and ergonomics.

WELL v2 has four features that address this criterion: Select Project Survey, Administer Project Survey, Utilize Enhanced Survey, Utilize Pre-and Post-Occupancy Survey. Additionally, there is another survey for thermal comfort.

Fitwel standard also contains an Occupant Satisfaction Survey to gauge occupant satisfaction.

LBC does not mention occupant satisfaction survey in its standard.

b) **CT Credit 1: Visual Comfort**

This requirement aims to provide adequate lighting to provide visual comfort.

i) Daylighting

Projects are to have at least 50 % of the occupied spaces receive daylight illumination of minimum 110 Lux.

WELL v2's feature of Daylight Design Strategies specifies that 70% of all workstations are to be within 7.5 m or 5 m of the building glazing.

Fitwel requires that 51% of the floor area are to have access to natural light.

LBC requires 95% of the area to have daylight access and views in its Healthy Interior Performance Imperative.

ii) Illumination Levels

Projects are to have a general illumination level of 215 lux is maintained in at least 75% of occupied spaces.

WELL v2 considers this criterion in its feature titled Provide Indoor Light where it specifies a target illuminance of 200 lx.

Fitwel does not mention illumination levels but it gives the option of following LEED IEQ 8.1.

LBC does not specify illumination.

- iii) **Brightness Relationship**
At least 75 % of the project area has to meet the requirement of brightness relationship specified in the National Building Code 2016.
WELL v2 in its Balance Visual Lighting feature specifies that the contrast ratios between horizontal and vertical luminance is not more than 10.
Fitwel does not specify any brightness relationship.
LBC does not specify a brightness relationship.
- iv) **Glare Index**
At least 75 % of the project areas are to meet the requirement of limiting Glare Index at 19.
WELL v2 in its feature Managing Glare from Electric Lighting specifies a Unified Glare Rating of 16 or lower.
Fitwel does not mention Glare Index.
LBC does not mention Glare Index.
- v) **Occupant Satisfaction**
Project teams are to conduct a visual comfort satisfaction survey to show the percentage of satisfied occupants.
WELL v2 has four features to measure satisfaction holistically. However, it does not have a separate survey for visual comfort only.
Fitwel also has an occupant satisfaction survey for overall satisfaction, but not one only for visual comfort.
LBC does not have any occupant satisfaction survey.

c) **CT Credit 2: Thermal Comfort**

This requirement aims to provide comfortable indoor thermal environment.

- i) **Operative Temperature, Humidity and Air Velocity**
Operating temperature, humidity and air velocity are maintained as specified for at least 75% of operating hours.
WELL v2 covers this criterion in its Provide Acceptable Thermal Environment feature. It also has a feature to manage relative humidity. For managing air flow, it specifies windows with multiple opening modes, desk or ceiling fans for individual control.
Fitwel does not specify a temperature, but calls for access to thermal controls to individuals. It requires Relative Humidity to be between 30% to 60%. It does not mention anything about air velocity.
LBC requires the ability for occupants to influence their local air flow and temperature. But does not mention Relative Humidity.
- ii) **Occupant Satisfaction**
Projects are to demonstrate that occupants are satisfied with respect to their thermal comfort.
WELL v2 does not demand an occupant satisfaction survey specifically for thermal comfort
Fitwel does not call for a satisfaction survey for thermal comfort.
LBC does not call for an occupant satisfaction survey for thermal comfort.

d) CT Credit 3: Acoustic Comfort

This requirement aims to reduce noise levels and provide acoustically comfortable environment.

i) Noise Criterion and Reverberation Time

At least 50 % of the spaces shall meet the recommended levels of Noise Criterion (NC) and Reverberation Time (RT). For offices, the NC recommendations are 25 to 45dB. Reverberation Time recommended is less than between 1.25 seconds and 0.6 seconds.

WELL v2 recommends 40dB to 55 dB. *WELL v2* also specifies RT of equal to or less than between 1.5 seconds to 0.6 seconds.

Fitwel does not specify any such noise levels or reverberation time, but provides for a quiet room.

LBC does not specify any noise levels or reverberation time.

ii) Occupant Satisfaction

Projects are to demonstrate that occupants are comfortable with respect to the noise level in their environment.

WELL v2 does not demand an occupant satisfaction survey specifically for noise.

Fitwel does not address noise reduction and does not call for a satisfaction survey for noise also.

LBC does not call for an occupant satisfaction survey specifically for noise.

e) CT Credit 4: Olfactory Comfort

This requirement aims to minimize odor in service areas to reduce discomfort.

i) Exhaust Systems

Projects are required to isolate zones from other areas and provide exhaust system with an exhaust rate of at least 0.5 cfm per sf.

WELL v2 has a criterion for called Source Separation which requires a project to isolate and properly ventilate indoor pollution sources.

Fitwel has a criterion for ventilation, but does not address olfactory comfort. Additionally, *Fitwel* calls for ventilation of chemical storage areas also.

LBC requires that direct exhaust be provided for bathrooms, kitchens and janitorial areas.

ii) Occupant Satisfaction

Occupants are to be comfortable with respect to the olfactory comfort in their environment.

WELL v2 does not demand an occupant satisfaction survey specifically for olfactory comfort.

Fitwel does not call for a satisfaction survey for olfactory comfort.

LBC does not call for satisfaction survey for olfactory comfort.

f) CT Credit 5: Ergonomics

This requirement aims to provide ergonomically designed spaces for occupants.

i) Ergonomic Space and Furniture Design

Spaces and furniture are to be ergonomically designed as per Time Saver Standards.

WELL v2 has four features that address ergonomics: Support Visual Ergonomics, Implement and Ergonomics Program, Commit to Ergonomic Improvements, Support Remote Work Ergonomics.

Fitwel provides for active workstations, but does not address ergonomics in particular.

LBC provides for flexible options for working and/or varied sensory experiences for working. But it does not address ergonomics in particular.

ii) Occupant Satisfaction

80% of the occupants are to be satisfied with respect to the comfort levels of space and furniture in their environment.

WELL v2 does not demand an occupant satisfaction survey specifically for ergonomics.

Fitwel does not call for a satisfaction survey for ergonomics.

LBC does not call for an occupant satisfaction survey specifically for ergonomics.

g) **CT Credit 6: Comfort for Differently Abled Occupants**

This requirement aims to ensure that the facility caters to differently abled occupants.

i) Comfort for the Differently Abled Occupants

The facility has to provide comfort for differently abled occupants as per NBC-2016, Part-3.

WELL v2 requires a project team to integrate universal design.

Fitwel calls for universal accessible pedestrian route and a transit stop.

LBC calls for safeguarding access for those with physical disabilities.

D) Health & Sanitation

a) **HS Credit 1: Housekeeping**

This requirement aims to have well-defined procedures in place to maintain cleanliness and hygiene.

i) Following Housekeeping Protocol

The facility has to follow housekeeping protocols for all spaces.

WELL v2 has three related features, viz, improve cleaning practices, select preferred cleaning products, address surface hand touch.

Fitwel requires a project to establish and maintain a regular cleaning protocol for bathrooms and break areas.

LBC also requires a project to develop a Healthy Indoor environment Plan that addresses cleaning protocols.

ii) Integrated Pest Management Plan

A project has to implement a pest management plan as per the National Building code, 2016.

WELL v2 requires a team to manage pests per an integrated pest management plan

Fitwel requires a project to establish and maintain an integrated pest management plan.

LBC does not address the pest issue.

b) **HS Credit 2: Eco-Friendly Chemicals**

This requirement encourages the use of eco-friendly housekeeping chemicals.

i) Using Eco-Friendly Chemical Products

The facility has to use certified eco-friendly housekeeping chemicals. *WELL* v2, in its feature, Select Preferred Cleaning Products, requires the use of products that are certified low-hazard and safe.

Fitwel requires a Green Purchasing Policy under which products are to comply with certain listed codes.

LBC also requires a project to use cleaning products that comply with the EPA Safer Choice Label.

c) **HS Credit 3: Control of Outdoor Dust Pollutants**

This criterion requires a project team to minimize entry of outdoor dust into the facility.

i) **Using Door Mats and/or Air Curtains**

The facility has to use door mats and/or air curtains at all building entrances.

WELL v2 requires a project team to design health entryways or systems like grilles, grates, slots, or rollout mats, and two or three typically closed doorways.

Fitwel requires a project to have entryway systems at all entrances to the project.

LBC also requires the prevention of particulates and toxins through an entry approach.

E) **Fitness & Nutritional Choices**

a) **FNC Credit 1: Fitness Facilities**

This requirement aims to provide fitness facilities for the occupants.

i) **Access to Indoor Fitness Facilities**

The project has to have an indoor fitness facility.

WELL v2 requires a project to offer physical activity opportunities, indoor and outdoor physical activity spaces and incentives.

Fitwel offers numerous options for physical activity indoor and outdoors.

LBC does not specifically call for access to fitness facilities.

ii) **Access to Outdoor Fitness Facilities**

The project has to have an outdoor fitness facility.

WELL v2 requires a project to offer physical activity opportunities, indoor and outdoor physical activity spaces and incentives.

Fitwel offers numerous options for physical activity indoors and outdoors.

LBC does not specifically call for access to fitness facilities.

b) **FNC Credit 2: Awareness on Physical Fitness**

This requirement aims to create awareness and encourages occupants to adopt practices to improve their physical fitness.

i) **Awareness**

The facility has to adopt measures to create awareness among employees.

WELL v2 offers incentives for promoting physical activity and provides self-monitoring tools.

Fitwel provides for a health promotion programming for occupants.

LBC does not provide for awareness of physical fitness.

ii) **Encouragement**

The facility has to adopt measures for encouraging employees.
WELL v2 offers incentives for promoting physical activity and provides self-monitoring tools.

Fitwel provides for a health promotion programming for occupants.

LBC does not provide for encouragement of physical fitness.

c) **FNC Credit 3: Nutritional Choices**

This requirement aims to encourage increased consumption of healthy options for better health.

- i) Provide healthy nutritional options as part of menu; Eliminate Trans Fats
 The facility has to provide healthy nutritional options as part of the menu and eliminate trans fats.

WELL v2 promotes and encourages healthy food items in their menu through various methods. It also eliminates trans fats.

Fitwel provides health food options and for eliminates trans fats.

LBC does not mention anything about nutrition in its standard.

- ii) Display nutritional facts; Educate occupants on nutritional facts
 The facility has to display nutritional facts on the menu and, in case there is no cafeteria, educate occupants on nutritional facts.

WELL v2 displays nutritional information in their menu and promotes nutritional education.

Fitwel requires creation of a healthy food and beverage policy with nutritional information listed. It encourages healthy choices.

LBC does not mention anything about nutrition in its standard.

2) **Emotional & Intellectual Well-Being**

a) **E & IW Credit 1: Exterior Connectivity to Occupants**

This requirement aims to develop green landscape and provide connectivity.

- i) Green Ratio

At least 15% of the site area has to have green cover.

WELL v2 provides connection to nature and nature, and access indoors and outdoors. It requires that a project have at least 1.25 acres of green space.

Fitwel provides ample opportunities for green connection. But it does not require a minimum green area.

LBC seeks to nurture human-nature connection. However, it does not specify any minimum area for green cover.

- ii) View to Outdoor Environment.

At least 25% of the spaces are to have direct line of sight to outdoor environment.

WELL v2 requires 75% of all workstations and seating to have a direct line of sight to nature views.

Fitwel requires at least 51% of the workstations to have views of outdoor natural elements.

LBC requires the provision of views outside for 75% of the occupied spaces.

- iii) Access to Exterior Landscape

The project has to have at least two options for enabling access to landscape.

WELL v2 provides nature access indoors and outdoors.

Fitwel provide ample opportunities for green connection.

LBC promotes frequent human to nature interactions indoors and outdoors.

b) **E & IW Credit 2: Color Psychology in Interiors**

This criterion requires a project to adopt the use of color psychology in interior finishes including furniture, soft furnishing and lighting design for positive effects of colors.

i) **Color Psychology in Interiors**

Projects are to adopt color psychology strategies for enabling a positive effect on employees.

WELL v2 only mentions the need for using calming colors in restorative spaces.

Fitwel does not mention this criterion.

LBC does not mention this criterion.

c) **E & IW Credit 3: Spiritual Well-Being**

This criterion requires a project to provide an environment to embrace spiritual activities.

i) **Encouragement to Embrace Spiritual Activity**

Projects are to encourage employees to embrace spiritual activity.

WELL v2 requires the promotion of mental health and well-being. But it does not mention spiritual activity.

Fitwel does not mention spiritual activity.

LBC does not mention spiritual activity.

3) **Social Well-Being**

a) **SW Credit 1: Recreation and Culture**

This requirement encourages activities that enable bonding among occupants.

i) **Celebration of Festivals**

Employees are encouraged to celebrate at least two national or cultural festivals.

WELL v2 promotes community engagement, but does not mention anything about celebrating national or cultural festivals.

Fitwel does not mention this criterion.

LBC does not mention this criterion.

b) **SW Credit 2: Employee Safety**

This requirement requires a project to ensure safety measures for occupants.

i) **Women's Safety**

The organization has to have a women's safety committee, transit facilities for women, and other women's safety policies.

WELL v2 does not specifically address women's safety. However, it calls for diversity and inclusion and for connecting employees to transit facilities.

Fitwel calls for specific measures to increase perception of safety and to reduce crime. It also calls for facilitating transit. But it does not address transit facilities only for women.

LBC does not mention anything about women's safety.

ii) **Safety Measures**

The organization has to have safety protocols in place and adequate measures to ensure safety of their employees.

WELL v2 promotes emergency resources and supports emergency resilience. It addresses safety of various types along with response action and teams.

Fitwel also requires the implementation of emergency preparedness plans and creation of relevant infrastructure and personnel.

LBC does not mention anything about preparing for emergencies.

c) **SW Credit 3: Service to Society**

This requirement requires a project to ensure engagement in community welfare activities.

i) Adopting a UNDP Sustainable Development Goal

Projects are to demonstrate that the organization has adopted one of the listed UNDP Sustainable Development Goals.

WELL v2 helps achieve a number of the listed goals.

Fitwel also helps achieve a number of the listed goals.

LBC also helps achieve a number of the listed goals.

4) **Innovation and Design Process**

a) **ID Credit 1: Innovation and Design Process**

This requirement encourages innovative design and performance beyond the criteria listed in the *IGBC H & W* framework.

i) to iv) Innovation & Design Process

Projects have two options to choose from: option 1 gives a credit for innovations not found in the framework. Option 2 gives credit for exemplary performance.

WELL v2 offers 10 credits for innovations beyond the framework.

Fitwel does not have this criterion.

LBC also does not have such a criterion.

b) **ID Credit 1: IGBC Accredited Professional**

This criterion requires an IGBC Accredited Professional to be part of a green building project.

i) IGBC Accredited Professional

Projects are required to have at least one IGBC Accredited Professional in their team.

WELL v2 requires a *WELL v2* Accredited Professional in the project team.

Fitwel does not have this requirement.

LBC requires one *Living Future Accredited Professional* in the project team.

7. Results and Discussion

IGBC H & W appears to be modelled on the *WELL v2* framework. Like *WELL v2*, *IGBC H & W* addresses air, water, thermal comfort, ergonomics, sound (acoustical comfort), visual comfort and more. Under *WELL v2*, mental health is an important consideration which is elaborately addressed in its Mind concept. *IGBC H & W* uses the Emotional and Intellectual Well-being criteria to address some criteria related to mental health.

However, *IGBC H & W* creates a unique space for itself by aiming to address Indian realities as discussed below.

1. An Indian Approach

IGBC H & W aims to represent an Indian approach. This is mentioned in its introductory note where it philosophically interprets the connection between the five elements of Earth, Water, Fire, Air and Ether to human senses which it calls consciousness, and lists human organs responsible for specific perceptions related to those organs.

However, the logic of how the elements mentioned came to represent their related consciousness, organs and perceptions is not mentioned. Hence, the philosophical interpretation seems unclear. This may need attention for future updates.

Despite this lack of clarity, there are some criteria that represent Indianness in some ways, or are unique, if not Indian. These are:

- a) Spiritual well-being credit
- b) Women's safety under the Employee Safety credit
- c) Celebration of national or cultural festivals under its Recreation and Culture credit
- d) The credit for Service to Society

However, the idea of spirituality seems to need definition. A note mentions that spiritual activity is not to be connected to religion. The question that arises, therefore, is about which activity is spiritual and which is not. Hence, the term spirituality needs a specific definition for the context.

The idea of service to society has been part of Indian society and is said to be ancient with individuals, kings, religions, and, later, states offering service to society in the form of social work (Thomas, 2010). However, it is not unique to India and is seen in volunteer service and activism in other countries. It is also a part of *WELL v2* in its criterion requiring promotion of community engagement.

2. Criteria that are absent in *IGBC H & W*

Based on this study, it emerges that there are several criteria that are not part of *IGBC H & W*. These are:

A) Diversity and Inclusion:

Diversity and inclusion are part of *WELL v2* and *LBC*. Both these frameworks encourage organizations to employ people with diverse backgrounds. *WELL v2* specifies the following groups:

- a) Gender (assigned, identity and/or expression)
- b) Sexual orientation
- c) Race/Ethnicity
- d) Age
- e) Socioeconomic background
- f) Level of ability
- g) Other metrics as identified by the project.

LBC identifies vulnerable or disadvantaged populations including minorities, women, disadvantaged business enterprises or its equivalent. It requires that projects must have a JUST label that shows the extent of diversity and inclusion among other aspects of an organization.

IGBC H & W does not make a mention of various minorities, socio-economically disadvantaged, socially disadvantaged, diversity in religious denomination and inclusion of other forms of vulnerable or disadvantaged populations. The framework would benefit from including these and other populations as mentioned under *WELL v2*.

B) Public Awareness/Education:

WELL v2 offers a credit for organizing *WELL* educational tours for the public to educate and encourage them to adopt healthier choices and lifestyles. *LBC* offers a credit for Education + Inspiration and lists out what a project needs to do to achieve the credit.

IGBC H & W does not mention anything about educating the public and spreading awareness except under the criteria of fitness and nutrition. However, it does offer a credit for spreading awareness and educating the occupants of the project. This credit can be extended to educate the public. Alternatively, an additional credit can be offered for this purpose.

C) Beauty

LBC, uniquely, encourages inclusion of the idea of beauty in the project. It mentions biophilia as a way to introduce beauty. However, it also encourages the introduction of public art and design features that are intended solely for human delight.

IGBC H & W will benefit from including this criterion of beauty in a project, whether in the form of biophilia or public art or through the use of other creative interventions in a project.

D) Green Building Design

WELL v2 offers a credit for a project to achieve a green building rating aligning itself with the larger green building objectives.

IGBC H & W may also indicate its alignment with the green building movement by offering a credit for achieving a green building certification.

E) Carbon Reduction

WELL v2 requires a project to reduce emission of carbon until a project achieves carbon neutral status. *LBC* requires projects to achieve net positive carbon status. However, *IGBC H & W* does not mention carbon reduction in its framework. Including this criterion will help make the framework more complete.

8. Conclusion

As is seen above, *IGBC H & W* appears to be modelled on the *WELL v2* framework. However, as we have seen, *IGBC H & W* aims to offer an Indian perspective to health and well-being and bases its framework on philosophical foundations of five elements of nature.

IGBC H & W also lists credits for some requirements that can be identified as Indian. These are spiritual well-being, women's safety under the Employee Safety credit, celebration of national or cultural festivals under its Recreation and Culture credit, the credit for Service to Society.

However, there are several criteria of *WELL v2* and *LBC* that are not found under *IGBC H & W*. These are Diversity and Inclusion, Public Awareness and Education, Beauty, Green Building Design, and Carbon Reduction. *IGBC H & W* will be benefit by including these criteria in its framework.

Additionally, this study also helps contribute toward the United Nations' *2030 Agenda for Sustainable Development* by addressing SDG 3 which relates to Good Health & Well-being by working toward the evolution of a framework for achieving good health and well-being for humanity.

Many urban building projects strive to achieve high ratings under these frameworks. It is expected that peri-urban architecture will follow this trend. This will help reduce health concerns arising out of modern work routines in the peri-urban areas. This will also help in creating better living and working conditions in peri-urban areas benefiting populations in these zones.

Acknowledgment

I thank my research guide, Dr. S. R. Bhagat, Dr. Babasaheb Ambedkar Technological University, Lonere, Maharashtra, (A State Technological University) for his advice, guidance and support in writing this paper.

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Earthquake Resilient Housing Technologies

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Abstract:

Today the buildings and cities all over world are facing destructive forces and diverse challenges due to fast urbanization, natural disasters like flooding, earthquake, storm, etc. these causes more damages to the building structures, cities and livelihood of city. To overcome such damages due to disasters the resilient structure is adopted.

In India, many cities/regions come under earthquake pore zones and facing the problem that leads to destruction of buildings and cities. This brought the need of resilience in the buildings from earthquake. some of the core cities faces the problem with conventional way of construction also being developing country there is a need of rapid construction with resilience.

This research paper sates and evaluates the treat and challenges faced in India at the earthquake prone zones and identifies the earthquake resilient strategies and advanced construction technologies.

Keywords: Resilience, disasters, earthquake, resilient strategies, advanced technologies.

1. Itroduction:

In India many cities face problems during earthquake, major damages to the buildings effects the livelihood of the city. To overcome such problems, the resilient strategies in construction should be used. The resilience in building makes it more safe and sound. There is no need to argue on the vulnerability of buildings and cities in the entire region to understand the necessity to build resilience in all components and dimension of the city.

1.1 Aim and objectives

The challenges faced by environmental everyday by the effects of change in climate, population growth and environmental degradation. These challenges came be overcome by making smatter, better and in more resilient ways. This paper aims on the need to promote the concept of resilience in architecture through learning the strategies and advanced technologies.

The focus is to upgrade the knowledge and intricate our skills related to the advanced technologies for the people those are in the construction sector that makes cities, buildings more safe and resilient from hard hitting calamities.

By adapting the advanced technologies, can help us build resilient cities in an affordable cost in different seismic zones. India being developing country the advanced technology advantages in the faster construction in an economical solution.

2. Literature review

2.1 Calamities in India:

2.1.1 Cyclone

Cyclones usually arises due to the atmospheric disturbances in the low-pressure area that can be understood by the swift reflectance and often destructive wind movements. Cyclones generally arises with the violent storms and winds with a bad weather.

2.1.2 Tsunami

Tsunami arises when the earth's lithosphere breaks up into pieces, called plates that tends to move around the planet. This motion drives up the flow of the mantle rock below the earth's crust and by the forces plate is exerting at their boundaries where the plates touch one another. When it is forced to drive beneath another piece of lithosphere, the component of vertical motion results in tsunami.

2.1.3 Heat Wave

These are the abnormal high temperatures, that are higher than the maximum neutral temperature that arises during the hot summers in the north-western parts of the country. Heat waves sometimes occurs between march and June, and in rare cases these are even extended till the month of July. The extreme climatic temperatures and resultant atmospheric conditions highly affect the lives of people those are living in these regions as there are these physiological stresses, sometimes resulting in death.

2.1.4 Landslide

India having the largest mountain range on earth, the Himalayas, which were formed years ago due to collision of Indian and Eurasian plate, which results in the of Indian plates moving towards China, arises due to the stress on the rocks rendering them friable, weak and prone to landslides and earthquakes.

2.1.5 Urban floods

Urban flooding can be termed differently as of rural flooding as urbanization leads to developed catchments and land pockets. Urban areas are usually densely populated and the people who live in vulnerable or flood prone areas suffer due to flooding, thus resulting in loss of life sometimes.

2.1.6 Floods

India is highly vulnerable to floods. Out of its total geographical area around 8% of land is flood prone. Floods are a recurrent phenomenon, that cause considerable amount of loss of lives and damages to livelihood, public properties, infrastructural elements and utilities. It is being recorded to be increasing in earlier scenarios, which is been seen as a cause of concern.

2.1.7 Earthquake

A phenomenon that involves violent shaking of the ground and life over it. It results from the release of the stimulated stress of the moving lithospheric or crystal plates. Earthquakes occurs due to the tectonic plates, responsible for violent shakes. The occurrence of an earthquake in a densely populated area may have adverse effect on lives of people as well as extensive damage to property.

3. Resilience:

The ability to absorb changes and disturbances and still maintain the same relationships between populations or state variables is the measure of the persistence of the systems known to be called as resilience.

Table 1

Calamities	Areas	RESILIENCES	
		Needs:	Resilient cities
<ul style="list-style-type: none"> • Cyclone • Earthquake • Climatic Change • Floods • Landslide • Famine etc. 	<ul style="list-style-type: none"> • Globally • In India 	<ul style="list-style-type: none"> • People • Houses • Other buildings • Infrastructure 	<ul style="list-style-type: none"> • Settlements • Towns • City
Need in India	Other factors :	History:	Case Study :
		<ul style="list-style-type: none"> • Area of destruction • Impact • Destruction % • Measures • Preventions 	<ul style="list-style-type: none"> • Construction tech. • Resistivity • Damages • Criteria

Source: Author

This report is to understand the past incidences happened due to calamities in India that affected geographical areas and measures taken to protect the housing of people affected. Also, to familiarize with the advanced technologies to resist those calamities driven by the past incidences.

4. Case Study

1. Uttarakhand faces the extent of frequent climatic disasters. The significance and role of various departments in sectors, such as forest and biodiversity, agriculture, water resources, livestock, health and energy, in addressing climate change and climate risk management issues throughout the state. Strong support was seen for having a regulatory framework, and planned infrastructure, such as public health care, communication and transportation developing a resilient built environment. Hence, it shows perception of variability on the significance of departments for addressing disasters caused by climate change.
2. This study in Odisha emphasizes on community coping with structural and non-structural safety aspects in the built environment and proposing methodologies to generate strategic planning for resilient buildings in cyclone prone areas affected by Fani, the extreme severe cyclonic storm along odisha coast. Hence it is need for a coordinated strategic plan for attaining disaster resilience community to rescue the victims affected from disaster management activities. Vulnerable part of structure are foundations and materials, thatched houses, tiled buildings, concrete/prefabricated structures.
3. Assam situated in north-east India is exposed to multiple hazards of seismicity due to the tectonic plates below the earth's crust, resulting in floods and cyclones to a critical extent. Also the vernacular architecture of assam is sometimes unable to withstand the disaster due to intensified calamities that are brought in by climatic change, majorly depleting materials that are

indigenous, and intervention of popular and modern technologies using vernacular materials from the past. Bamboo, being an engineering material is suitable and versatile in application and its use. Due to its mechanical properties are suitable for structural applications in terms of high strength/weight ratio, ductility, low cost, faster reproduction and simple manufacturing processes, it has gained the repute of engineering material.

5. Methodology

5.1 Principles

One of the most important principles is to think how resilient involvement can create value in terms of underwriting of building operations and in terms of decreasing the harm to users and community. Using the data and the research on the damages and the climatic change the various vernacular strategies should be adapted. Identifying the reason for resilient design or the resilient strategies in construction and operation. Promoting small innovations and experiments that offsets the cost of climate change.

6. Advanced Technologies:

6.1 Pre-fabricated sandwich panel system

The pre-fabricated sandwich panel system are more environmentally friendly building materials which enhances the building with required strength. When applied to low-rise buildings, these technologies allow to obtain a cellular structure composed of cast in situ sandwich squat concrete walls sustains the load of gravity and act as shear walls to resist the lateral loads. This method also provides designer to use different type of materials preferably lightweight materials.

In this construction process the site is cleaner and dust free as the cement panels are manufactured in industries under controlled conditions and then dispatched on the site. Also, the erection process which is a headache part, is reduced in this system.

Aim of this technology is to make building more ecofriendly, hazard resilient and more importantly to make it sustainable. This technology speeds the construction process with better quality and are cost-effective.



Figure 6:1: Steel structure installation

Source: Prefabricated sandwich panel system in India

https://ijaers.com/uploads/issue_files/4IJAERS-07202147-Prefabricated.pdf

6.2 Light gauge steel structural systems

Steel is a building material widely used as a building material all over the world. The steel is considered to be uneconomical for landed properties, whereas we see use of timber, structural brickwork and reinforced concrete structures are preferable.

The economical steel frame is developed through cold framed process and is used in various countries.



Figure 6:2 : Example of structural design for LGSF Construction

Source: Light Gauge Steel Frame Building Construction

<https://theconstructor.org/structural-engg/light-gauge-steel-frame/37722/>

It is an advanced technology building material, designed for the construction of prefabricated buildings and structures. LGSF technology uses high quality galvanized steel profiles in load bearing wall, inner walls, floors slabs roofing frames, it facilitates maximum utility space.

The manufacturers produce a light weight but high tensile steel sheets as the light gauge steel is developed without the use of heat through the cold formed process.

These steel sheets are made by processing the metallic scrap and then undergoing the process of a cold-formed. The steel is shaped by guiding thin sheets of the steel through a series of rollers (of changing shapes), resulting in the c or s-shaped sections.

The sheet surface is then coated with a zinc alloy that completely covers and makes it corrosion resistant. The steel frame structures are durable and can last up to 50 year of time.

6.3 Monolithic tunnel formwork

This system is a type of formwork system in which the RCC slab and walls are constructed in a continuous pouring of concrete. For medium to high rise buildings with same plans repeating due to effective performance during calamities like earthquake, industrialized, modular construction technique, low cost and time saving. Recent studies show that the current seismic codes and guidelines do not provide sufficient requirements for the seismic design of these structures. In this methodology, the fundamental period and the proposed behavior factor (R factor) are used to compute the design base shear of a structure.



Figure 6:3 : Tunnel formwork

Source: Introduction to advanced TUNNEL Formwork system - IRJET
<https://www.irjet.net/archives/V4/i3/IRJET-V4I397.pdf>

The tunnel formworks consist of 2 half cells, 1 shaped that are made of steel that are joined together to form a cell unit. The main components of this system are walls and flat plate slabs, where in-situ concrete is poured into two half-tunnel forms to shape load-bearing walls and floor slabs simultaneously. With this technology the rapid constructions are done, the units can be casted within 24 hours. The two functions of the walls in tunnel form buildings are that they resist lateral loads as well as they carry vertical loads. Due to monolithic slab and walls the structure becomes more seismic resistant. Due to reduced number of joist, the water tightness is improved.

The project which has been constructed using advanced technology that is tunnel formwork.

The project name is Rohan Abhilasha. Rohan builders India Pvt. Ltd. is the organization under which the construction took place. The project is located in Wagholi-Lohegaon road, Pune, Maharashtra, India.



Figure 6:4 : The building at Finishing Stage



Figure 6:5 : Transformer room using Tunnel Form

Source: <https://www.irjet.net/archives/V4/i3/IRJET-V4I397.pdf>

Construction is a complex and risky process requiring extensive planning, engineering and construction management. When all of these activities operate in concert with each other, the result is a successful project. Formwork is key component of any structure; quality of construction is directly depending on formwork used. There are various types of aluminum formwork used in construction industry from conventional formwork to special forms. Real estate construction industry has a reputation of not being very technologically worldwide, generally lagging in new innovation, advanced construction techniques & management. But now a day's lot of research is carried out in this sector, advanced tunnel formwork is good examples of this innovation.

In case project involves more than 20 storied building over large area, total economics may change considerably. However, this aspect will require further study to arrive at conclusion. At present only RCC items for towers are taken into consideration & respective time and cost to complete same is worked out using tunnel formwork and Alu-form.

6.4 Holiday home in Light Gauge steel



Figure 6:6 : Holiday home 1



Figure 6:7 : Light gauge steel frame

Source: <https://tatabluescopesteel.com/wp-content/uploads/2017/12/Amboli-Project.pdf>

The holiday home is located at amboli hill station, Sindhudurg, Maharashtra, India.

The location is in western part of India in Sindhudurg region of Maharashtra.

Also, this area requires a strong and maintenance free structure, since it receives a heavy rainfall.

It is known to be reliable method for construction. The remote location was a challenge for this project. The construction procedure was quick and sturdy completed. Highlighting features of the project were that wall frames and trusses area made of high strength g550mpa zinc-alum alloy coated cold rolled steel which ensures its corrosion resistance. The steel frame ensured quick and easy installation. The entire system is having self-drilled screws with high durability and long life for structural as well as roof and wall sheeting.

7. Findings:

From the study, following are the parameters for the research:

We can understand the calamity incidences happened in past onto the geographical aspects in India and the various measures taken to develop and rebuilt the urban resilience in various regions of India. The study shows the way how natural calamities have affected the human settlement, the structures and buildings. To overcome the damages due to earthquake the vernacular constructions principles were

seen to be helpful to avoid damages and makes structure earthquake resilient. Hence this study helps us understand the useful advanced construction technologies that are not much used in India but are used in various countries. These advanced construction technologies can be used to make building calamity resistant. To make structures resilient to earthquake the advanced technologies like monolithic tunnel formwork, prefabricated sandwich panels system, light gauge steel systems can be effective in achieving earthquake resilient buildings.

8. Analysis

The essential development and land use policies that protect individual, build economy, enhance community and enrich environment now need to be adapted due to the change in environmental and social conditions. To overcome damages, protect the cities from the hazards that are occurred due to climatic change there is need of resilience. By adapting principles of resilience we can balance the sustainable aspects with respect to ecological system and human settlement. To incorporate the urban resilience either the conventional construction principles should be improvised or the implementation of advanced technologies should be adapted. In Indian context various calamities hitting the cities brought a need of impactful technologies, which have already been tested and applied in various other countries. The technologies which are effective for earthquake that are used in various other countries are monolithic tunnel formwork, prefabricated sandwich panel system, light gauge steel frame system.

9. Discussion

Considering the advantages of advanced technologies like affordable, time saving, easy installation, easy material transportation and better than conventional construction system, it is seen to be used successfully in India.

The regions where conventional construction system is a hard, the advanced technologies can be useful. The developing region where there is a need of fast construction these technologies can be helpful. Using these technologies, the structure gains modern aesthetics. These technologies are more recommended in seismic zones in India.

10. Recommendations:

Need to upgrade the skills related to new technologies that are resilient from earthquakes. As India is a developing country where there is more need of building constructions, the advanced technologies can be used because the advanced technologies are not time consuming, are affordable and can be earthquake resilient. The advanced technologies like tunnel form work, prefabricated sandwich panels and light gauge steel, these technologies are more effective in building earthquake resilient structures.

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"UNDERSTANDING SOCIO-CULTURAL AND ECOLOGICAL RELEVANCE OF SACRED GROOVE IN WESTERN GHATS MAHARASHTRA- PANSHET VALLEY."

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Abstract: The present study deals with the ecological and socio-cultural relevance of sacred groves in the Western Ghats of Maharashtra, India. Geographically, the research area is limited to two river valleys in the Sahyadri Ranges to the west of Pune. This area is full of biodiversity and is a part of Western Ghat. They are located on the historical route connecting Konkan and Pune via *Thipthipya Ghat*. Community-protected areas are known as SGs. The harvest of sources is restricted, even though they provide numerous direct benefits to the Community. People could benefit from the healing properties of SGs as ethno medicines, the use of lifeless and fallen timber, seed series for nearby forestation programmers, and restricted irrigation from a nearby water supply. Locals prepared and registered as a village forest safety and control committee to eventually perform the groves' healing work. In the valley of this river, there are also some *Dhangar* deities. Temples to these deities can be found at the intersections of the pastoral route. *Bapujibuwa*, *Viroba*, and *Masoba* are the main deities in this temple. The *Dhangars'* traditional dance is Gaja Nach, which means elephant dance. An SG of *Panphet*, which addresses relic vegetation of the space, demonstrates that in case appropriate assurance is guaranteed, a decent quality semi-evergreen forest can develop well.

Keywords: western ghats, sacred grooves, socio-cultural, Community.

1 INTRODUCTION

1.1 Concept of the sacred groove:

The grooves were god's first temples where man learned to hew the shaft and lay the architrave. In the darkling wood amidst the calm silence, he knelt. (Bryant, 1848) (Gadgil M. a., Sacred groves in the Western Ghats in India, Economic Botany, 1976) Defined the SGs as 'sizable patches of forests where all forms of vegetation including shrubs and climbers are under the protection of the reigning deity, and the removal, even of deadwood is taboo.' They further state that this type of preservation of the entire vegetation in association with a deity is quite a distinct phenomenon from the conservation of isolated specimens of sacred tree species such as Peepal - *Ficus religiosa* and Umber - *Ficus glomerata*, which are often preserved and worshipped even without any association with a deity. Religious beliefs and indigenous rituals have affected care and respect for nature in India and other parts of Asia and Africa since time immemorial. Every aspect of religious and cultural traditions is intertwined with the forest, which aids in environmental protection. These types of woods are associated with the concept of "holy groves." (Khan, 2003) In general, SGs are areas of virgin forest that are rich in biodiversity and traditionally maintained by local communities. Our country has practiced setting

aside patches of forest land and leaving them intact based on traditional communities' religious beliefs for centuries.

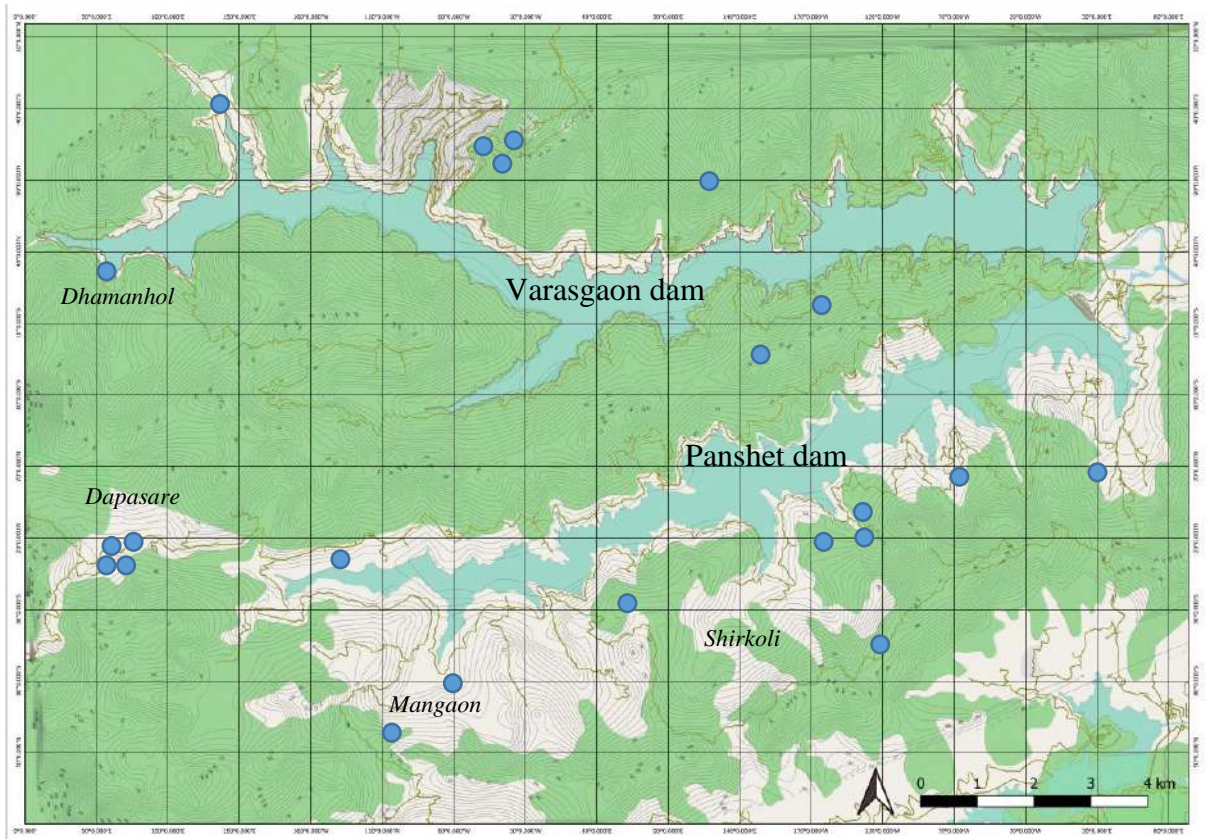
1.2 Sacred groove in the Western Ghats

The genesis of SGs in the Western Ghats may go back to hunting-gathering societies, which attributed sacred values to patches of forests within their territories as they did to other topographic or landscape features like mountain peaks, rocks, caves, springs, and rivers. Despite the rising popularity of worship in temples (several of them constructed in place of groves), the groves, although diminished in area, persist as an integral part of the eco-cultures of most pre-Brahminic agricultural societies. Therefore, the practice of protecting Devrai ¹(SGS) increased insignificance with the arrival of agriculture. In addition to their role as the abodes of gods, the groves would have protected a range of landscape elements with their characteristic biodiversity. The larger groves would also have functioned as resource patches where non-timber forest produce could be harvested in a regulated fashion. The groove in the Western Ghats broadly falls under two categories: the smaller groves are entirely protected no tree felling, or other biomass extraction may be allowed. Larger grooves function as resource forests, offering livelihood sustenance and ecological security. (Gadgil M. &., 1992)

1.3 The study area:

Geographically, the research area is limited to two river valleys in the Sahyadri Ranges to the west of Pune. Pune District is located at about 18° 32" north range and 73° 51" east longitude. Pune lies at the western margin of the Deccan plateau, at an altitude of 560 m above sea level. It is at the leeward facet of the Sahyadri mountain range, a barrier from the Arabian Sea. *Panshet* Valley Dam, additionally called Tanajisagar Dam, is a dam at the *Ambi* River, a tributary of the *Mutha* River, approximately 50 km southwest of Pune in western India. *Panshet* is one of the well-known picnic spots of Pune and draws many site visitors from Mumbai. The lake is made due to the backwater from the *Panshet* Dam; from the dam, travelers can see the Sahyadri Mountains. (Dikshit, 2002)

¹ Devrai / Devrahati: sacred groove



Map 1 Catchment area of Panshet and Varasgaon Dam (Source: Author)

1.4 Geology:

The catchment area forms a part of the excellent trap region of the Deccan. Deccan trap is the result of volcanic lava flows. Black basalt stone is prominently found in this area. Beds of Basalt and Amygdaloidal alternate, the upper and lower planes being strikingly parallel to each other. Basalt, which covers almost 90 percent of the area, usually is dark grey or blue-grey. The rock weathers into a disintegrated form known as *murrum*² and finally produces soils of varying depth, texture, and color. (Sulabha Brahme, 1986)

1.5 Socio cultural aspect:

SGs are community-protected areas. Though they yield numerous direct advantages to the Community, the harvest of sources is restrained. People could advantage from the healing of SGs as ethno medicines, lifeless and fallen timber, seed series for nearby forestation programmers, and constrained irrigation from the water supply close to the grove. It is the local people prepared and registered as village forest safety and control committee to in the end, perform the healing work of the groves. Also, some deities of the *Dhangar*³ community are in the valley of this river. These deities are mainly male deities. Where there is a junction of the pastoral route, we see temples of these deities. This temple is primarily of deities like *Bapujibuwa*, *Viroba*, *Masoba*. *Gaja Nach*,⁴ which way the dance

² Murrum: disintegration of rock i.e., fragments of rock

³ Dhangar: Dhangar is a name of an Indian herding caste.

⁴ Gaja Nach: traditional dance form of the Dhangar community

of elephant, is a traditional dance of the *Dhangars*. Since it's far considered auspicious, the dance is likewise finished on the time of temple festivals. *Katkari*⁵ had been traditionally woodland dwellers.

Sr.no	Name of the village	Name of the divine force	No of Devarai
1	Shirkoli	Shirkai	1
2	Shirkoli /rule	Vaghjai	2
3	Shirkoli	Manai	1
4	Dhangaon / dapasre /kuran /kharavde	Mhasoba	4
5	Thangaon	Bapujibua	1
6.	Adamal	Kalkai	1
7.	Dhamanohol	Dhamanohol	1
8	Dapasare	Jakhini /laxmi	1
9	Dapasare	Mahadev	1
10	Dapasre	Somjai	1
11	Mangaon	Janani / janai	1
12	Shirkoli	Kambal Bhairavnath	1
13	Mose bk	Kharal baba	
14		Guloba	1
15	Saiv bk	Parjai	1
16	tekpole	Gavdevi	1
17	Vanjarwadi	Vardayini	1
18	katavadi	Umbarjai	1

Table 1 selected case study throughout te region (source: Author)

⁵ Katkari: The name Katkari is derived from a forest-based activity – the making and sale of catechu (katha) from the khair tree (*Acacia catechu*).

2.1 Shirkoli group of sacred grooves:

The grove devoted to *Shirkai* at Shirkoli that extended over some 4 hectares is now reduced to 1.5 hectares. The cutting and hacking of trees in the sacred grove is continuing for some decades. Hardly any rare species are preserved, except for *Zanthoxylum rhetsa*. Despite the encroachment, the faith in the presiding deity persists.



Map 2 Map of Shirkoli village showing the location of sacred grooves Source: author

An old temple of *Shirkai Devi* built by *Ranisaheb* of *Satara* in the 18th century was submerged in the reservoir, some part of the sacred grove is also submerged, *Shirkoli* sacred grove is a temple sacred grove where the temple is centrally placed and around the temple sacred grove is there. The goddess is the presiding deity of the *Mose* valley and the *bagad*⁶ festival is celebrated. During British rule, most



⁶ Bagad: A religious mortification. Swinging, by means of a hook introduced under the muscles of the back, from a cross-piece passing over a post either planted in the ground or fixed on a moving cart.

of the *bagad* in Maharashtra was wiped out. *Bagad ustav* of *Shirkai* in the *mose* valley and *Vaghjai* in the *Mutha* Valley are still worshiped today. *Sasankathi* of each deity in the river valley come to meet the goddess for the celebration of this deity

Shirkoli, the biggest town in the *Panshet* catchment region is of distinct recorded interest. The sanctuary got lowered in the *Panshet* repository and presently the divinity is held up in a brief shed, on the primary full moon day of spring (*Chaitra Purnima*) customarily wild ox was forfeited at the sanctuary of the goddess *Shirkai* and afterward the goddess was conveyed in a cart to the *bagad* site. *Shirkoli* idols address her as *Mahisasurmardini*; this Kosambi theory addresses displacing of the bison-keeping *Dhangars* by *Raje Shirke* who settled down in the broad plans sloping country. These stones are either *tandalas* formed like rice grains or *Chiras* moulded like points. A couple of sharp metal guides are trust into the back and the snared man is passed on to swing from a crossbar fixed on a wooden shaft. That is the way, as the legend goes *Shirkai* was set up in the town which came to be named after the god *Shirkoli*. The well-established ceremonies are as yet noticed however in an adjusted structure and the deep-rooted convictions continue as the dread of the obscure is solid.

2.2 Mangaon scared grove:

Mangaon village is located in *Velhe* Taluka of Pune District, Maharashtra. This village is remotely situated in the catchment area of the *Panshet* reservoir along the Western Ghats. At a distance of 70 km from Pune city, the village can be approached by the state transport buses till Panshet (30 km) and by launch there onwards. The village is surrounded by the Western Ghats on one side and the backwaters



Map 3 Map of Mangaon showing location of sacred groove Source: author.

of Panshet Reservoir on the other. This is mainly a forest ecosystem situated on the Crestline of the Western Ghats. The forest under protection is a sacred grove that is revered by the villagers of *Mangaon* since times immemorial. The area of the sacred grove is 18 ha and is legally a reserved forest (RF)

under the jurisdiction of the forest department. The main communities residing in *Mangaon* are the *Marathas*, *Dhangars*, *donger Kolis*, and *Mahadev Kolis*⁷. The total population of the village is 450.

SGs are very revered in the villages, and they have been nurtured. Sacred groove in this area is mostly of female deities, rarely male deities are seen in this area, all these deities are associated with each other, and they are considered as relatives of each other. In every village, there is a female deity, and that deity is worshiped as the protector deity of the village.

3.3 Socio-cultural

- The concept of the sacred groove is derived from *Krishi Sanskriti*. The things that are worshiped in the agricultural culture are the same things that are worshiped in these deities. An important part of the agricultural culture is the farmer and his livestock. I found that deities established in this sacred groove are for the protection of this livestock from wild animals. That is why we see the names of deities like *Waghjai*, *Bhairoba* in this sacred grove.
- Sacred groove in the *Panshet* region is primarily kept up with by a particular ancestral local area. Among them are *Katkari*, *Dhangar* and *Mahadev Koli* people group.
- The call *Katkari* is deduced from timber primarily grounded on the total activity of the timber and trade or trade of *Katechu* (*Kath*) from the *Khair* tree (*acacia katechu*). It's produced with the aid of using boiling timber from the *Khair* tree and sinking the preceding pop. This makes a tanga applied in Ayurvedic remedial sauces and duos bit with betel leaves.
- As indicated over the current biomass assets are being utilized to address the issues of fuelwood, for house development, for charcoal making. Lumber and bamboos are cut available to be purchased.
- Animals are the principal wellspring of vocation for the *Gavli Dhangars*. They have been possessing the upper porches with adequate brushing terrains and space populace. Customarily wild ox was the principal milk steers kept up with by the *Dhangars*.
- The eating routine by and large comprises a *pani bhakar* and bean stew powder or onion to swallow it with. The *Dhangars* can't stand to have vegetable side-dishes or curry in their everyday diet.
- Regardless of the way that the *Gavli Dhangars* have been occupying a plot wealthy in wild creatures, they had not fostered any custom of hunting,
- However, their customary eating routine, which was for the most part dependent on home-delivered animal items - mainly milk and milk products, some poultry, and honey, natural products, nuts, and other forest items along with the millets they developed, it is figured, furnished them with sufficient protein and calorific admission.
- Places of *Mahadev Koli*, *katakari*, *Dhangars* in the greater part of the bunches are poor and built utilizing nearby material.

⁷ Mahadev koli: Mahadev Koli or Mahadev Koli Are Sub caste of Koli Community of Maharashtra and Goa States of India. They Are Classified As Schedule Tribe But They Are High Respected Then Other Tribes.t

sacred grooves and associated communities

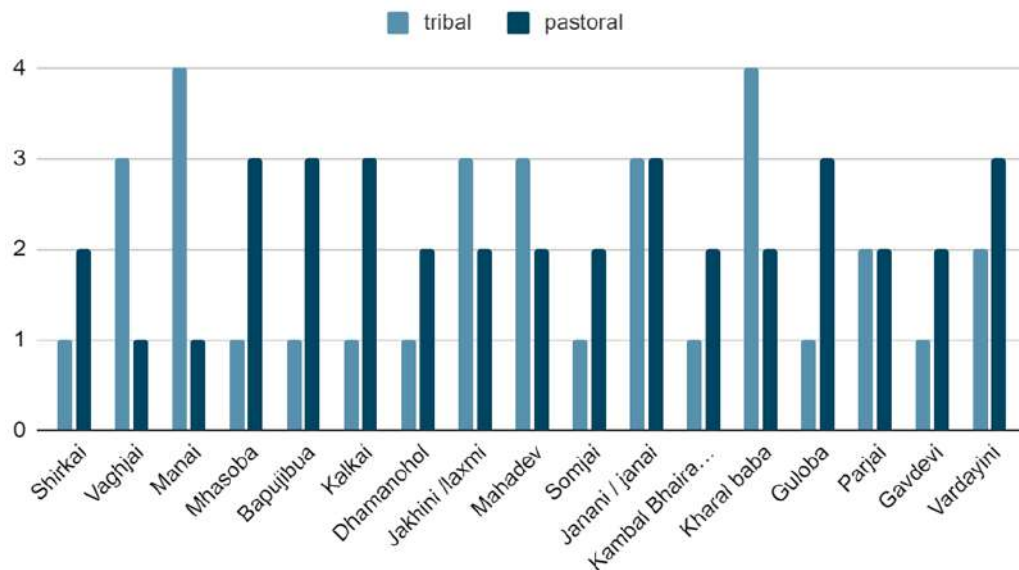


Figure 1 Chart Showing sacred grooves and associated communities (source: author)

4. CONCLUSION:

Conservation of sacred forests is subsequently crucial for the protection of the abundance of the Western Ghats. After researching I was able to classify SGs into two major categories those are,

1. Ban⁸ or jaai or jalli⁹ – associated with the female deity
2. Rahat or raai¹⁰ – associated with the male deity

A sacred groove refers to a specific type of tree or group of trees that are protected by local communities using traditional conservation knowledge. SGs are always associated with a divine force that aids in their survival in urban areas. Local beliefs and taboos also benefit the conservation and protection of its habitat. Geography is a very important part of these forests, soil, air, and water all affect the forest directly and indirectly. SGs are found mainly near a major water source. This source is perennial and considered as sacred. Geography is the cultural study of a place. The sacred groove affects all of them and whether it is the tribal communities, or all other local communities depends on the SGs, and these groves are also indirectly complementing our environmental conservation. Genuine advances must be taken earnestly as these are not any more rationed and secured on strict conviction. The absence of elective hotspots for wood and fuelwood is driving individuals to infringe upon the holy forests. A prompt program for kindling and lumber tree manor, restriction of business double-dealing of the backwoods assets of the catchment region, and an arrangement of the precise redevelopment of the holy forests and full security to the current vegetation in the forest must be arranged forthwith and carried out in participation with the nearby occupants. The sacred forest should be completely shielded from a wide range of obstructions to safeguard the biotic variety. Gadgil and Vartak's (1973, 1976) perceptions during their review support Kosambi's theory, that the *Janni* sacred forest has a place with the hunting-gathering phase of society.

⁸ Ban: small forest

⁹ Jali: group of trees

¹⁰ Rahat: small patch of forest

ACKNOWLEDGEMENTS

I am grateful to my guides Dr. Vaishali Latkar and Ar. Sonal Chitnis Karanjikar for their constant support, encouragement, and guidance to which the research could not have been completed.

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Groundwater Capacity and Stress – Implications for Planning in Coastal Areas, A case of Puri, Odisha

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Abstract : Groundwater resources assessment has resulted in development of several models that help identify the vulnerable zones and help in developing strategies for groundwater replenishment. However, the use of groundwater resource assessment for plan-making for an urban area are rarely found. While many Indian cities rely heavily on ground water, the input of groundwater assessment in planning process, in decisions related to land use and decisions related to city expansion and densities, are seldom found. This study attempts to take up this concern and showcase how assessment of ground water resources can be suitably used for planning. It takes up the case of Puri city, a city of eastern Odisha, which is completely dependent on ground water. This study presents two GIS-based hydrogeological index, named GALDIT and DRASTIC model, aiming at the assessment of aquifer vulnerability and seawater intrusion in coastal aquifer of Puri. GALDIT model is described to assess and quantify the significance of vulnerability to seawater intrusion due to excessive groundwater withdrawals. The study also applied the DRASTIC model to obtain a more realistic assessment of vulnerability of groundwater in terms of its availability and potential for use. Various parameters were studied under both the models and weights were assigned for each parameter by an analytic hierarchy process (AHP) to reduce the subjectivity of humans to vulnerability assessment. The study then identified the critical wards which have high water demand and developed a water resource management plan that attempts to put control and check on the volume of extractable ground water. The approach was to shift the dependency from groundwater to surface water. Planning controls on land use concentration that are heavily dependent on water has been suggested. An integrated and comprehensive planning approach has been developed that does not limit the economic and demographic growth of the city, but conserves and replenishes the ground water resource has been suggested.

Keywords: GALDIT model, DRASTIC model, AHP, aquifer, salinization, coastal aquifer vulnerability, land use land cover.

1. Introduction :

Groundwater is the water that exists beneath the Earth's surface and fills all or part of the void spaces in soils and geologic strata. The term "groundwater" refers to precipitation that has infiltrated the soil below the surface and accumulated in voids underground. Confined and unconfined aquifers are the two types of aquifers. Unconfined aquifers reside beneath a permeable layer of soil, whereas confined aquifers have an impenetrable layer of rock or clay above them. (Guo1, 2018).

When rain falls on the ground, some of it flows along the land surface to rivers, lakes, and streams, while the rest moistens the soil. A portion of this water is used by plants, while the rest evaporates and returns to the atmosphere. A portion of the water seeps into the ground, travels through the

unsaturated zone, and eventually reaches the water table, which is a hypothetical surface where the ground beneath is saturated. (Balamurugan Gurul*, 2014). "Groundwater represents about 30% of world's fresh water. From the other 70%, nearly 69% is captured in the ice caps and mountain snow/glaciers and merely 1% is found in river and lakes. Groundwater is critical to the environment because it maintains the water level and flow into rivers, lakes, and wetlands. To avoid overexploitation and pollution of this vital resource, the most important aspect of using groundwater is to strike the right balance between withdrawing and allowing the aquifer's level to recover. "Water is stored in large quantities in the ground. Precipitation that infiltrates downward from the land surface provides the majority of the water in the ground is known as groundwater capacity. Whereas, Groundwater stress is the ratio of groundwater withdrawal to recharge rate over a specific aquifer is referred to as groundwater stress. Excessive pumping can cause the water table to drop so low that the wells no longer provide water—they can "go dry."

Groundwater is significantly decreasing due to over exploitation and over extraction. As the population is increasing, the dependency on groundwater is also increasing. This is leading to reduction of groundwater. Specifically in coastal areas, there is another problem called groundwater salination. This happens because deep down the aquifers containing portable water there are aquifers containing salt water which is non-potable. This is commonly found in coastal areas.

2. Study Area Profile :

Puri is a coastal area in the Indian state of Odisha. It is the district headquarters of Puri district and is located on the Bay of Bengal, 60 kilometres (37 miles) south of Bhubaneswar, the state capital. It is also known as Sri Jagannatha Dhama, after the city's 12th-century Jagannath Temple. For Hindus, it is one of the original Char Dham pilgrimage sites. (Municipality, 2016)



Figure 1: Key Map

2.1 Demography

Puri district has a population of 1,698,730 in 2011, with 865,380 males and 833,350 females. In the 2001 census, the area had a population of 1,502,682, with 763,389 males and 739,293 females. (CEPT, 2013). When compared to the population in 2001, there was a 13.05 percent change. Puri district's population increased by 15.12 percent between 1991 and 2001, according to the previous Census of India. According to preliminary Census of India 2011 data, the population density of Puri district in 2011 is 488 people per square kilometre. Puri district density was 432 people per square km in 2001. Puri district covers an area of 3,479 square kilometres.

2.2 Water Supply in the Area

The city obtains its drinking water from the ground via tube wells outfitted with motorised pumps and hand pumps. Because the city is near the sea, the ground water near the sea beach is salty. There are two major sweet water zones about 2 to 3 kilometres from the seashore that serve as the

city's primary source of drinking water: one in Chakratirtha to the east and one in Baliapanda to the west. The Chakratirtha well field covers 497.68 acres, while the Baliapanda well field covers 207.52 acres. Several production wells have been drilled in these two areas to extract water from the well fields and supply it to the communities. In addition, production wells have been sunk in other areas of the city to supplement the supply to the community as well as to various institutions and government residential offices/quarters/houses. River Bhargabi has tributaries such as the Kanchi and Dhaudia. During the summer, however, these tributaries have no water. The river Mahanadi at Naraj, which is 90 kilometres away, is the nearest surface water source to be tapped for drinking purposes.

3. Need for the Study

Among all countries in the world, India is the largest user of groundwater. Groundwater development in India is extremely limited. That is why there is more groundwater depletion in India. If this is not addressed now, the country will face water scarcity very soon. In Odisha, the coastal areas are facing problem for saline water intrusion. Aquifers in coastal areas are frequently subjected to seawater intrusion, which degrades groundwater quality.

The movement of saline water into freshwater aquifers can cause groundwater quality degradation, including contamination of drinking water sources, among other consequences. Because of the hydraulic connection between groundwater and seawater, saltwater intrusion can occur naturally in coastal aquifers. Because saline water contains more minerals than freshwater, it is denser and has more pressure. As a result, saltwater can make its way inland beneath freshwater. Submarine groundwater discharge can push fresh water into saltwater in other topologies. (&, 2021). Certain human activities, particularly the pumping of groundwater from coastal freshwater wells, have increased saltwater intrusion in many coastal areas.

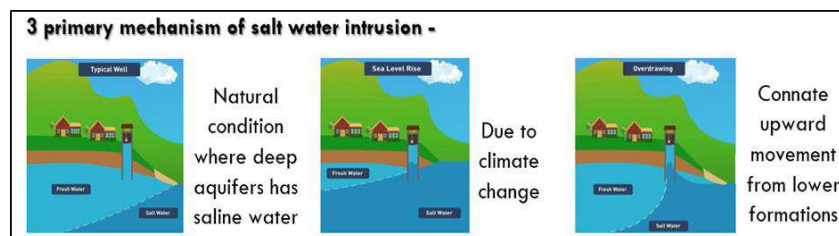


Figure 2: Salt water intrusion mechanism

Because Saline water has a higher mineral content and is denser and high pressure than fresh water. In natural condition saline water is found in deep aquifers in coastal regions.

3.1 LULC Change Study

The land cover has drastically changed in two decades from year 2000 to 2022. Dense vegetation cover reduced from 52 sq.km to only 7sq.km. The built-up area increased from 59 sq.km to 131sq.km which is more than double as compared to two decades ago. On present date, only 22% of the total area is available as unpaved area which is nearly 37 sq.km. Due to decrease in unpaved area rain water hardly percolate into the ground which results in decrease in groundwater level. The over population and encroachment in the city is putting stress on groundwater and simultaneously affecting the drinking water quality.

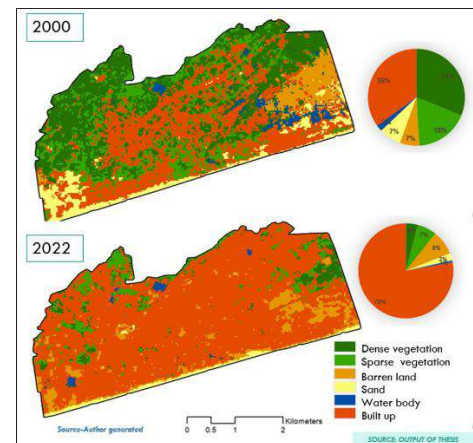


Figure 3: LULC change from 2000 to 2022

4. Research Framework :

The aim of this research is to “Assess Groundwater Capacity and Stress in Puri, in order to Restore & Conserve the Groundwater Resource.” This will be achieved through four objectives. (i) To understand the land use and existing baseline conditions of groundwater in Puri. (ii) To estimate the future vulnerability of Groundwater recharge zones in the region. (iii) To analyse the factors behind changes in Groundwater quality with particular emphasis on salinity. (iv) To estimate the water demand of the municipality and frame potential scenarios of Groundwater extraction in order to reduce the dependency on Groundwater and explore use of Surface water.

5. Research Analysis

5.1 DRASTIC Model

The DRASTIC model was developed by Aller et al. (1987) for the United States Environmental Protection agency (EPA), with the purpose of creating a methodology that would permit a systematic evaluation of groundwater pollution potential of any hydrological setting. Depth-to-water, net Recharge, Aquifer media, Soil media, Topography, Impact of vadose zone, and hydraulic Conductivity are some of the hydrological parameters used in the DRASTIC model. The model generates a numerical index based on the ratings and weights assigned to the model's seven parameters. Each parameter is further subdivided into ranges or significant media types, which are rated from 1 to 5 based on their relative impact on pollution potential. (Saatsaz*, 2011)

Based on their relative importance, the seven parameters are assigned weights ranging from 1 to 5. The DRASTIC index is then computed by applying the following equation to a linear combination of all factors.

$$\text{DRASTIC index} = D_r D_w + R_r R_w + A_r A_w + S_r S_w + T_r T_w + I_r I_w + C_r C_w$$

The seven parameters are D, R, A, S, T, I, and C, and the subscripts r and w refer to rating and weights, respectively. The DRASTIC index is calculated by multiplying each parameter rating by its weight and adding the results. The parameters are then weighted to express their relative importance to one another. The GIS environment is used for spatial data analysis and computerised mapping. (Adjusted, 2020)

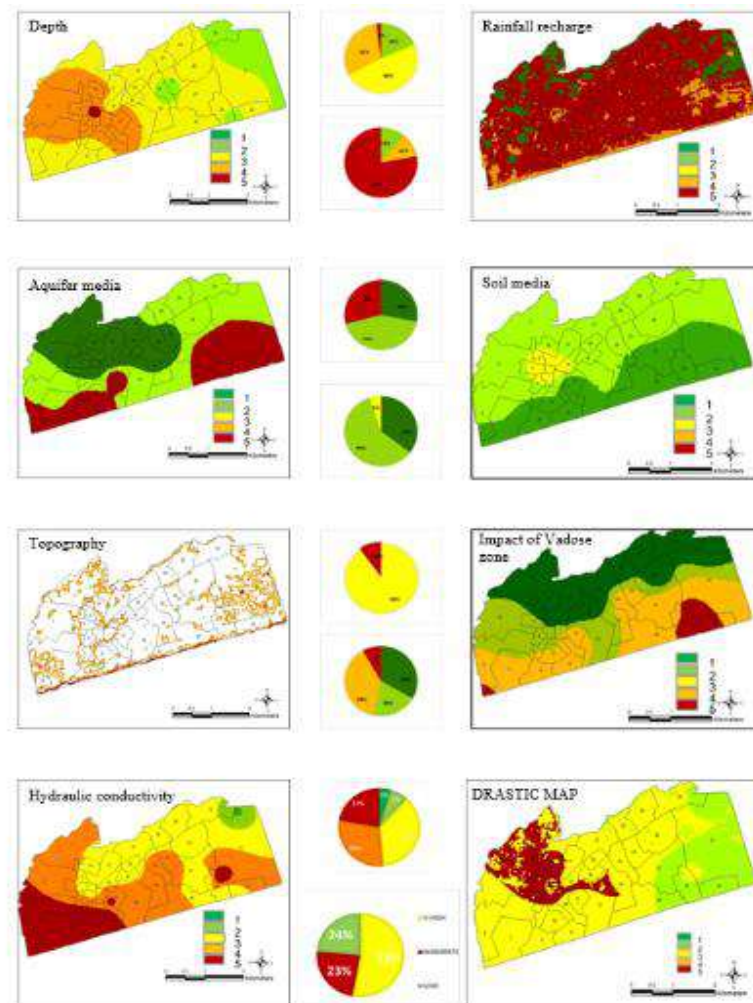


Figure 4: Parameter maps of DRASTIC model

Table 1: Scale of Vulnerability for each DRASTIC Parameters

PARAMETERS	VULNERABILITY					WEIGHTAGES
	V.LOW 1	LOW 2	MODERATE 3	HIGH 4	V. HIGH 5	
Depth To Water	0-1 mbgl	1-2 mbgl	2-4 mbgl	4-6 mbgl	> 6 mbgl	20 %
<ul style="list-style-type: none"> As per <i>NAQUIM report of CGWB</i>, the level below 6m experiences very high fluctuation. As the logic table, very few area in ward 2 is under v.high vulnerability. The water level ranges from 0.3m-6m below the ground 						
Net Recharge (Runoff rate)	0.1-0.4 mm/s	0.5 mm/s	0.6 mm/s	0.75 mm/s	0.9 mm/s	14 %
<ul style="list-style-type: none"> As per runoff coefficient of different landuses, the recharge rate has been calculated. If the runoff rate is more, the recharge is less. They are inversely proportional to each other. Built-up areas having more runoff rate and dense vegetation having less runoff rate as per <i>Centre For International Agricultural Research</i> 						
Aquifer Media	Alluvium silt	Alluvium clay	-	-	Alluvium	18 %
<ul style="list-style-type: none"> It represents the type of aquifer, if there is more porous or crack surfaces which will pollute the groundwater. The study area is found with alluvium, alluvium clay and alluvium silt aquifer type. As per <i>Centre For International Agricultural Research</i>, alluvium have less capacity of purifying water, hence more vulnerable. 						
Soil Media	Sandy	Sandy loam	Sandy silt	Sandy clay	Clay	12 %
<ul style="list-style-type: none"> As per <i>ICAR-Indian Institute of Soil Science</i>, sandy soil is having more water percolation capacity. So as per the logic table the city is under very low to medium vulnerability in water percolation through soil. 						
Topography	< 60m	40-60m	20-40m	20-10m	>10m	8 %
<ul style="list-style-type: none"> As the study area is a coastal area, we can find very low contours here ranging from 0-40m as per <i>NCCR</i>. Hence more areas are coming under high to very high vulnerability. 						
Impact Of Vadose Zone	35-40m	30-35m	25-30m	22-25m	15-22m	20 %
<ul style="list-style-type: none"> The vadose zone represents the distance the rain water has to travel to reach groundwater aquifer. In Puri, the vadose zone varies from 22m to 44m. As per <i>ICAR-Indian Institute of Soil Science</i>, vadose zone less than 15m is highly vulnerable 						
Hydraulic Conductivity	0-5 m/s	5-10 m/s	10-15 m/s	15-20 m/s	< 20 m/s	8 %
<ul style="list-style-type: none"> The potential for groundwater pollution is more for areas with high hydraulic conductivity zones. The hydraulic conductivity of study area is varying from 0.4m/s -37m/s. So the western part of study area is having more hydraulic conductivity, hence more vulnerable as per <i>CGWB</i> 						

5.2 GALDIT Model

The vulnerability index map generated by the GALDIT model identifies potentially vulnerable areas that are more vulnerable to saltwater intrusion than the other zones. The model in this study assigns appropriate weights and ratings to each feature class of parameters to aid in identifying site-specific seawater intrusion vulnerability and its landward extent.

$$SWI_i = \{(GwGr) + (AwAr) + (LwLr) + (DwDr) + (IwIr) + (TwTr)\} / \sum_{i=1}^6 Wi$$

$$SWI_i = \{(GwGr) + (AwAr) + (LwLr) + (DwDr) + (IwIr) + (TwTr)\} / \sum_{i=1}^6 Wi$$

Where SWI_i is the seawater intrusion vulnerability index value; G, A, L, D, I, and T are the parameters used in this empirical vulnerability index model; w is the assigned weights to a parameter; r is the assigned rating of a parameter's feature classes; and Wi is the sum of all assigned weights. The assigned weights and ratings of the GALDIT parameters result in the identification of areas that may be vulnerable to seawater intrusion.

For example, the parameters distance from the shore (D) and groundwater level in relation to mean sea level (L) are considered primary influencing factors to seawater intrusion and have weighted values of 5 and 4, respectively. Following that, the feature classes of these parameters are assigned rating values ranging from 1 to 5, and the higher ratings are assigned to the feature classes of a parameter influencing the seawater–freshwater interface at the site-specific scale. Similarly, the remaining parameters and feature classes are assigned weights and ratings based on their impact on vulnerability to seawater intrusion.

The GALDIT model, collected as thematic layers, was executed using systematically organised geoprocessing functions to calculate seawater intrusion vulnerability at each pixel.

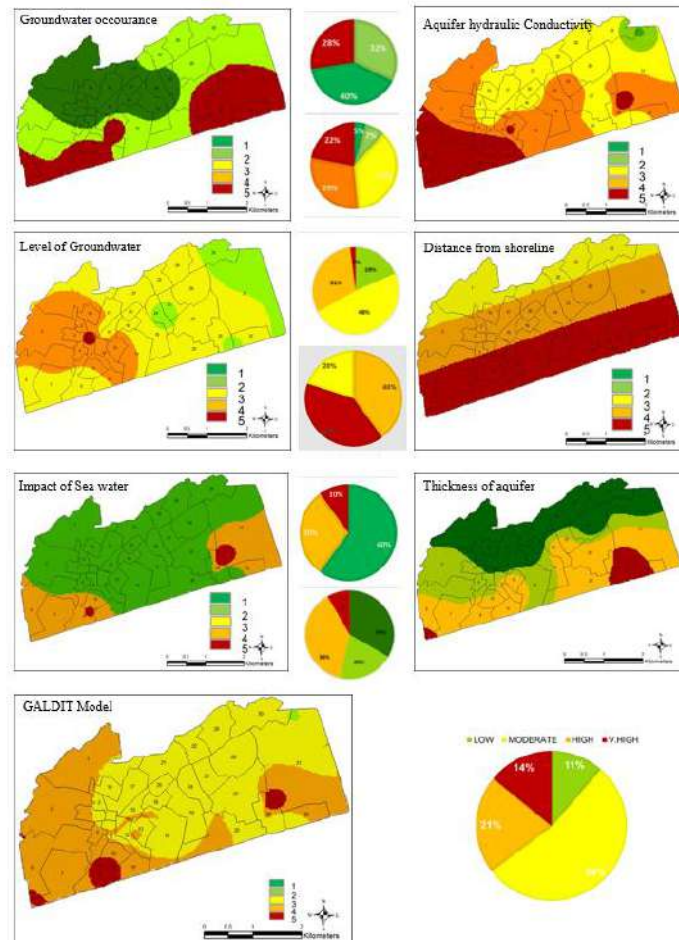


Figure 5: Parameter maps of GALDIT model

Table 2: Scale of Vulnerability for each GALDIT Parameters

PARAMETERS	VULNERABILITY					WEIGHTAGES
	V.LOW	LOW	MODERATE	HIGH	V. HIGH	
Groundwater occurrence/ aquifer type	Alluvium silt	Alluvium clay	-	-	Alluvium	10%
Groundwater occurs mainly in a water-bearing zone of permeable rocks or unconsolidated deposits (gravel, sand, or silt) along the coastal tracks. The aquifer characteristics are demarcated according to hydrogeological units using the reports of the Central Ground Water Board.						
Aquifer hydraulic conductivity	0-5 m/s	5-10 m/s	10-15 m/s	15-20 m/s	< 20 m/s	20%
<ul style="list-style-type: none"> The potential for groundwater pollution is more for areas with high hydraulic conductivity zones. The hydraulic conductivity of study area is varying from 0.4m/s -37m/s. So the western part of study area is having more hydraulic conductivity, hence more vulnerable. 						
Level of Groundwater	0-1 mbgl	1-2 mbgl	2-4 mbgl	4-6 mbgl	< 6 mbgl	20%
<ul style="list-style-type: none"> As per NAQUIM report of CGWB, the level below 6m experiences very high fluctuation. As the logic table, very few area in ward 2 is under v.high vulnerability. The water level ranges from 0.3m-6m below the ground 						
Distance from shoreline	5km	4km	3km	2km	1km	20%
The coastal aquifers within a proximity of seawater get influenced by coastal hydrodynamics as highly vulnerable to seawater intrusion. The spatial extent of coastal aquifers from the shoreline is estimated by identifying the high tide line (HTL) as a reference line. Unconfined aquifers closer to the shore (distance of < 1 km) have a higher vulnerability to seawater intrusion.						
Impact of sea water	0	1-2	2-4	4-5	< 6	25%
Impact of existing status of seawater intrusion is calculated by a ratio CI/HCO_3 .						
Thickness of aquifer	35-40m	30-35m	25-30m	22-25m	18-22m	5%
This parameter is used to estimate the amount of seawater intrusion into coastal aquifers. Increased thickness of the saturated zone results in lower saltwater levels and thus, decreased vulnerability.						

6. Water Availability and Extraction

A hydrologic process in which water travels downhill from surface water to groundwater is known as groundwater recharge, deep drainage, or deep percolation. Recharge is the most common way for water to enter an aquifer. This process normally happens below plant roots in the vadose zone and is commonly described as a flux to the water table top. Rain and snowmelt replenish groundwater, and surface water replenishes it to a lesser level (rivers and lakes). Human activities like as pavement, construction, and logging may obstruct recharge in several ways. Recharge can assist in the movement of surplus salts from the root zone to deeper soil layers or into the

For groundwater recharge calculation, amount of rain water percolation to the ground is required.

Where, Q = runoff, C = Coefficient of runoff, I = Intensity of rain, A = Area

The runoff has been calculated for different landuses.

Total percolation

QT = total runoff from different landuses

Total rainfall = $I \cdot A$, Percolation = $TR - QT - EV$

Where, ET = evapotranspiration

25% of the percolated water can be extracted from the ground.

groundwater system.

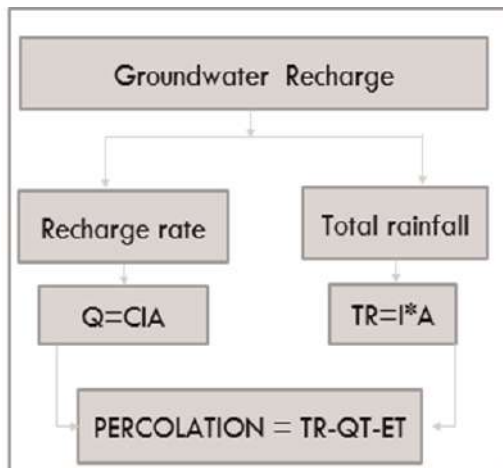


Figure 6: Groundwater recharge flowchart

Table 3: Storm water runoff in different Land cover

Storm water runoff				
Land cover	Runoff coefficient	Area (sq.m)	Intensity (m)	Total runoff
Dense vegetation	0.1	6930000	1.3523	937143.9
Sparse vegetation	0.5	11016000	1.3523	7448468.4
Barren land	0.6	14067000	1.3523	11413682.46
Sand	0.15	4212000	1.3523	854383.14
Water body	0	1071000	1.3523	0
Built-up	0.9	131463000	1.3523	159999673.4
Total liters				1806533513 10.0

The total rainfall (TR) = 228212795700 Liters per year i.e, 2.28×10^5 ML.

Total runoff (QT) = 180653351310 Liters per year i.e, 1.81×10^5 ML.

Evapotranspiration (EV) = 572093 Liters

TOTAL PERCOLATION = $TR - QT - ET$ $2.28 \times 10^5 - 1.81 \times 10^5 - 572093 = 4.76 \times 10^4$ M

25% of the total percolation is **11,88,97,18,074.25 liters i.e, 1.1×10^4 ML**

6.1 Surface water

Any body of water above earth is considered surface water, which includes streams, rivers, lakes, wetlands, reservoirs, and creeks. Despite being salty, the ocean is classified as surface water. A short perennial river flows near the city but not within the city limits. Dhaudia is the name of the river. Aside from this river, there are no other rivers inside the municipal limits. This is the closest running river.

N = MANNING'S ROUGHNESS COEFF, R = HYDRAULIC RADIOUS, S = SLOPE, D = DISTANCE TRAVELLED. The river Dhaudia, which is a tributary of the Mahanadi and flows, is the only source of surface water. It is a perennial river with very little water along the stream and is located around 3 kilometres from the city.

Peak discharge (Q) = $59.09 \text{ m}^3/\text{s} = 1863462.24 \text{ ML/Yr}$

30% of the total water can be extracted,

Extractable amount = $0.1 \times 104 \text{ ML}$

Hence the total amount that could be extracted from both ground water and surface water are

$1.1 \times 104 \text{ ML} + 0.1 \times 104 \text{ ML} = 1.2 \times 104 \text{ ML}$

6.2 Water Demand

The water demand calculation as per URDPFI for residential areas and NBC regulations for water demand for commercial and Public semi-public areas. Further the demand has been calculated for projected population of 2041 in residential areas only. All these demand has been calculated ward wise to know the ward level water demand as per the landuse.

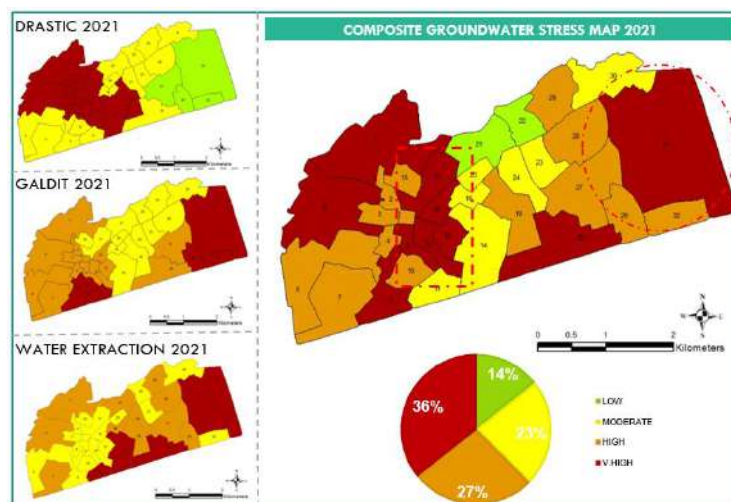


Figure 7: Composite Groundwater Stress

The stress map is generated by weighing DRASTIC Map, GALDIT Map and Water extraction map by giving 30% weight to DRASTIC map, 30% weight to GALDIT map and 40% weight to Water extraction map. The final stress map shows the wards having very high to vert low stress. 36% of the city is under very high stress, 27% of the city is under high stress, 23% of the city is under moderate stress and 14% is under low stress.

The maps show the ward wise stress as per DRASTIC, GALDIT and Water extraction and then the composite stress as per each of the pixel value using GIS.

7. Conclusion

The groundwater resources is one of the major source of drinking water and also a natural resource which needs to be conserved. For the sustainable development of groundwater there should be proper management methods implemented and regular monitoring system should be adopted.

The purpose of this study is to provide strategic information about groundwater management in a masterplan of any city. As of now groundwater management is a less concentrated chapter in every master plan and regional plan. But it is holding high importance to be studied. Specifically in coastal areas where salination is one additional problem including all other problems of groundwater quality and quantity degradation.

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Rurban upliftment of community and economy of Palghar by conversation and expansion of ecological context

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Abstract: Ecology is an essential part to set a character of a city with its natural setting, typology and human existence within. Ecosystems are under intense pressure due to growing cities, infrastructural development and changing climate. With advancing infrastructure and aspiration of urban lifestyle, depilation in ecosystem and biodiversity is evident. The bio diverse zones are becoming victims of this unrestricted urban growth. In addition, while planning and developing the city, ignorance has been made to the local ecosystem, which truly are the rich resource in food production and well-being of human life. This ecosystem is also a shelter of tribal, local communities that have rich diversity of living heritage, vibrant cultural practices, knowledge and skills, and are producing, safeguarding, maintaining, and recreating this ecosystem. Nevertheless, the shift and transition is so rapid in the world that is washing away all essential biodiversity, regional character and community.

The research is carried out in rurban context – a town of Palghar, which is rapidly growing and illustrates potential for growth. Palghar lies in a coastal as well as mountainous zone with varied layers of ecosystem that still housed local, tribal communities and diverse culture. The town, which lies into the northern expansion of Mumbai and southern expansion at the border of Gujarat, is soon becoming a hotspot of all urban aspirations, which are tangible, and changes happening are noticeable. This varied layer of ecosystem will diminish with time rapidly and the precious green dense belt will lose its regional status.

This paper aims to understand the ecoregion of Palghar, and highlight methods to create a valuable economy, an opportunity to sustain the urban transformation by retaining the regional identity and character. The objective of research is to create a balanced binary between the urban growth and rich Eco-sensitive zone, by protecting, conserving, enhancing and augmenting. However, creating public-private partnership programs will raise public awareness and educate people about their own rich essential context, economic betterment of people as well as greater social transformation. The method adopted for study is by studying the region of Palghar, findings from observation, interviews, and secondary data from articles, newspaper, site visits and case studies. Land and ecosystem degradation are the global crisis and it should be protected, restore, conserve and promote sustainable use of the terrestrial ecosystem, to avoid being buried under the concertized and digitalized world.

Keywords: Rurban, Ecology, Economy, Community, Urban expansion

1. Introduction :

Ecology enriches our planet and plays an important role in human well-being and economy. It emphasizes about the connection of humans and nature, which is critical for sustaining biodiversity in a changing climate, preserving clean resources for living beings, and developing a food production system. Every aspect in an ecosystem is either directly or indirectly dependent on every other factor. The entire surface is a network of interconnected ecosystems. People have engaged with these

ecosystems for decades, and numerous histories, cultures, habitats, and occupations have evolved and learned with each other.

As human population have grown, people have overtaken various ecosystem. The twenty-first century has been referred to as the first 'urban' or 'metropolitan' century (Clarke Alvarez et al., 2008; UN-Habitat, 2009; UNDESA, 2014; OECD, 2015). Approximately 54% of the world's population lives in urban region, with this figure anticipated to rise to 66% by 2050. Low- and middle-income countries are likely to experience the fastest rates of urban expansion. Furthermore, India is one among them, with the world's largest population and a diversified ecosystem.

We rely on biodiversity for ecosystem services, which are classified into four categories: providing, regulating, cultural, and supporting. These are offered by the earth free and are vital to achieving a planetary in balance. Ecocide should be considered as a new challenge and opportunity to conserve and protect the ecology, community, and traditional practices through the development of an Eco-economy.

2. Global risk :

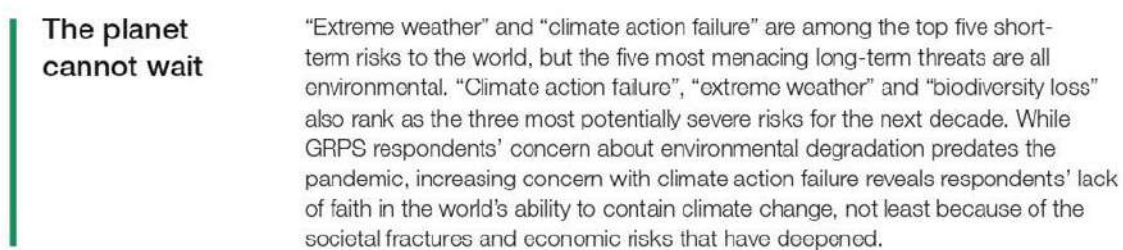


Figure 1: Global risks perception survey 2021-2022 results Source: Global Risk report 2022

When will risk become a critical threat to the world?

The World Economic Forum published its annual report; Global Risks Report 2022. It examines risk experts' and international leaders' opinions of global risk in industry, government, and civil society. The report looks at five types of risks: economic, environmental, geopolitical, sociological, and technical. The research identifies climate action failure as the greatest concerning long-term threat to the globe, with the most serious consequences expected in the next ten years. This report focuses on environmental issues the most. Global risk is significant in climate action failure, extreme weather, and biodiversity loss, as well as human environmental harm and natural resource crises, and this risk will deconstruct the ecology during the next ten years.

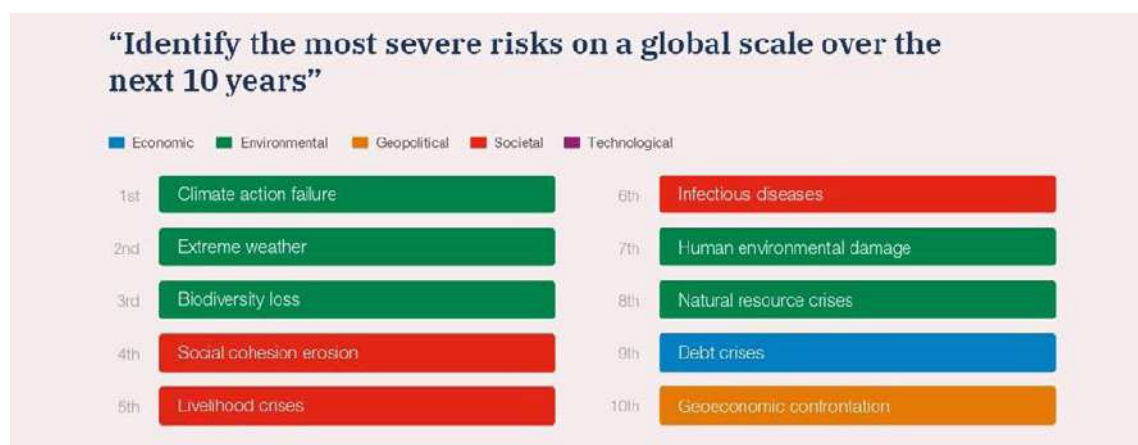


Figure 2: Most severe risk on global scale over 10 years, Source: World economic forum global risk perception survey 2021-2022

3. Palghar - A case of rurban setup

Palghar, the 36th district of the state, came into existence from August 1, 2014, by dividing the country's largest Thane district, which has maritime-mountainous and civil parts. Located in the northern part of Konkan, Palghar district is spread between the Sahyadri mountain range in the east and the Arabian Sea coast in the west. To the south of the district are Mumbai, Thane and to the north are Valsad (Gujarat) and Dadra and Nagar Haveli.

3.3 Demographic features:

Total population of district according to 2011 census is 29,95,428 lakh. %. The proportion of males is 72.23% and the proportion of females is 59.28%. The density of Palghar district is 560 per Sq. K.M. The Gender ratio of the district is 977. Percentage of urban and rural population, the urban population is 13,52,283. The rural population is 16,43,145. The population of the 8 taluka are Mokhada- 83,453, Jawhar- 140,187, Vikramgad- 137,625, Talasari- 154,818, Wada- 178,370, Dahanu- 402,095, Palghar- 550,166 and Vasai-Virar- 1,343,402. Scheduled Castes and Tribes account for 2.91% and 37.39% of the population, respectively. According to the 2011 census, 61.96% of the population spoke Marathi, 15.33% Hindi, 6.12% Varli, 5.61% Gujarati, 1.76% Urdu, 1.75% Bhojpuri and 1.01% Marwari as their first language.



Figure 3: Palghar district map
Source: Palghar .gov.in

3.4 Pattern of Land Use:

Palghar district has a total land area of 517634 hectares. According to the 2011 Census, the land use pattern shows that 42.00% is under cultivation and 37.00% under forest. The overall geographical area has 4.00% cultivable wasteland and 1.00% present fallow land. The district's cropping intensity is 101.90%, while the area shown more than once is 1.90%

3.5 Geographical Information

Palghar district has a total geographical area of 469699 hectares and contains 1007 villages and 3818 padas. There are also 467 Gram Panchayats. Palghar district's shoreline stretches about 112 kilometers. The district is located in the northernmost section of Maharashtra's Konkan plains. The Vaitarna is the primary river that runs through the district. The eastern half of the district features Sahyadri ranges, which are mostly forested. According to the geographical structure, the district generally falls into three divisions:

1. 'Jangalpatti': Jawhar, Mokhada, Vikramgad
2. 'Bandarpatti': Vasai, Palghar, Dahanu, Talasari taluks
3. The flat region: Wada taluka

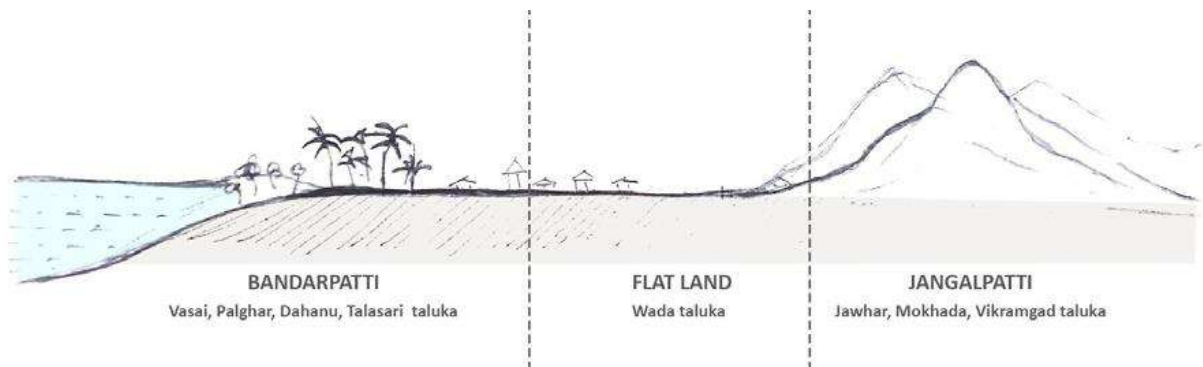


Figure 4: Palghar Geographical structure division Source: Author

4. Time line of Palghar :

1225 A.D.
century

- Shirgoan Fort built during Yadava of Devgiri.
- Under the Gujarati Musalman rulers in 1432.
- Portuguese in 1520-1533.

17th
century

- Portuguese built Kelwa fort.
- The Maratha army captured Kelwas fort on 10 January 1739.
- Marathas repaired the Shirgoan fort in 1772.

1818

- Both the forts was captured by British Army in 1818
- With the conquer of the forts vivid community settle in the place and coastal region of Shirgoan Satpati and Kelwa ,Mahim and practice occupation of fishing and agriculture.
- The forest area were exploited for wood smuggling and our spices from the forest

1869

- The present-day Western line started to take Form in 1867 when the Bombay, Baroda and Central India Railway (BB&CI) company constructed a line connecting Mumbai and Vadodara in Gujarat starting from what is Grant Road station today.
- The train route way emerge the new population group to come towards the railway.

1893

- Palghar station came into existence along with Boiser station.
- More easy connect work for trade was establish and raw material from Mumbai and Palghar were send to Surat from the rail route.
- Local people movement started along the station and other long distance places

1930

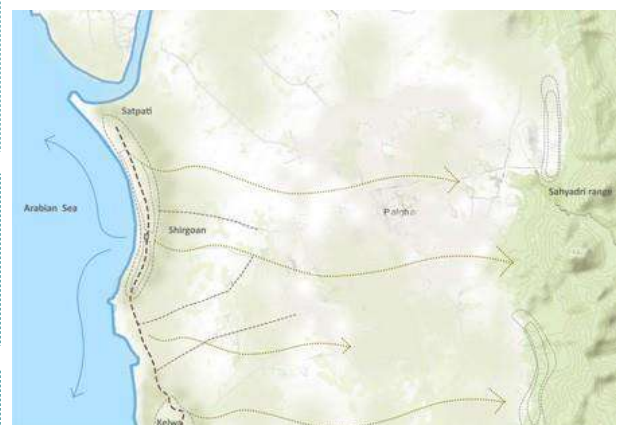
- When in the year 1930 'The Satyagraha Movement' was started in the country, many activists from Vadarai to Saatpadi were also involved.
- At Saatapadi all, the foreign objects were completely banned and destroyed.

1942

- When India's 'Go Back Movement' for independence from the British Empire began in 1942, the great 5 martyrs from Palghar gavetheir lives in support of the cause.
- Kashinath Hari Pagdhare of Saatpati, Govind Ganesh Thakur of Nandgaon, Ramachandra Bhimashankar Tiwari of Palghar, Ramchandra Mahadev churi of Murabe, and Sukur Govind More of Shirgaon all gave their lives for freedomfrom the British Kingdom.
- In commemoration of their sacrifice, a Martyr Square in Palghar was built and named 'Panch

1949

- The Local body manages Z.P. School, Palghar No. 1 Maharashtra was established in 1949 and it.
- This school is still functioning with the presence of the rural and tribal students.



1962

- MIDC-Maharashtra Industrial Development Corporation and industrial zone established in Boisar and Palghar that brought more no of migrant from outstation.

1968

- Sonopant Dandekar Shikshan Mandal was founded in August 1968 by the lovers of education to commemorate Late Sonopant Dandekar
- He used to express his desire that a town like Palghar be bestowed with a model institution, which could cater the need of higher education of this economically, socially and culturally backward area of Maharashtra.

2008

- St. John College of Engineering and Management (SJCEM) provides facilities for professional education in the rural and tribal area of Palghar District near Mumbai

2011

- The local train from Churchgate to Dahanu started was to increase the connectivity of the outstation
- This brought a major change in people flow and employment opportunities

2014

- On August 1, 2014, the Maharashtra State Government announced the formation of the 36th district of Maharashtra, Palghar, which was separated from the Thane district. Palghar District extends from Dahanu in the north to Naigaon in the south. Palghar, Vada, Vikramgad, Jawhar, Mokhada, Dahanu, Talasari, and Vasai- Virar are among its talukas.

2020

- With the easy of connectivity and development of Palghar varied housing scheme are introduced in Palghar.
- The housing urban planning lies on the main roads that connects the main town to the other small villages.

2022----

- CIDCO has been appointed as the authority for the development of the planned Palghar District Headquarters. CIDCO is expected to spend ~Rs. 3800 Cr. on the new township development. The project will include the building of residential, commercial and industrial zones.
- Wadhwan Port, is a proposed new port on the coast of Maharashtra state, India, 140 kilometres north of Mumbai. The port would be built on 5000 acres of sea-reclaimed land near the town of Dahanu in the Palghar district.
- The Maharashtra government has zeroed in on two places — Kelva-Mahim and Dapchari for Mumbai's satellite airport in Palghar district.
- State prison department has identified around 25 acres to construct a jail in Palghar district.

- The bullet train to acquire 191 hectares of private land, 60 hectares of government land and nearly 70 hectares of forest land in Palghar.
- Quadrupling work on Virar-Dahanu Road railway line with Eight new stations and several new structures, like station buildings at Virar, Vaitarna, Saphale, Kelve Road, Palghar, Umroli, Boisar and Wangaon-Dahanu road, are likely to come up.



The time line of Palghar demonstrate the rapid growth over the back few years. This region in past day was exploited for its rich ecological resource and by this today, it has the industrial zones and agricultural production lands. This ecological setting have attracted communities to settle in the region of Palghar. With the railway expansion the rapid urbanization is evidently seen and more influx of people is noted with new housing projects and infrastructure connections. Palghar in future have full potential to grow and be another hotspot zone for economy and infrastructure and thorough the time line it is seen that the growth is increasing and the ecology is decreasing.

5. SWOT Analysis of Palghar :

STRENGTH



- Unpolluted environs, with pleasant atmosphere.
- Emerging industrial hub.
- Have several historic spots and natural attractions such as beaches, waterfalls, lakes, farmlands and orchards.
- Maharashtra's biggest fishing center Satpati is located in Palghar.
- Well-developed real estate destination.
- Easy connectivity to Mumbai and Gujrat
- Fertile land for Agriculture.
- Spreading ecological networks in the west by the Arabian Sea and to the east of Sahyadri range.
- Tribal settlement with various culture practices.

OPPORTUNITIES



- The region is emerging with various government projects
- Palghar is seeing commensurate infrastructure development.
- More availability of land to expand
- Possible to grow the tourism sector
- New project will offer employment to the youth.
- To have sustainable practices
- The increase in demand of raw and fresh vegetables.
- To set up institution and education recreation and community engagement spaces as the region lack in it.

WEAKNESS



- Lack of community engagement spaces
- The rural villages are not uplifting with the resource they have.
- Can accommodate maximum population
- Palghar lack in planning the town with proper facilities.

THREATS



- The natural setting are depleting or unwanted interventions are created in them.
- The rapid Growth is losing the character of the town making it monotonous and rigid.
- The various infrastructure project will take away the ecological setting and agriculture rich lands.

Table 1: SWOT analysis of Palghar Source: Author

6. Ecology zone of Palghar :

Palghar has varied layer of ecosystem. The city lies in the center of the flat lies, which have sahyadri range to the east and Arabian Sea towards its west having community variation and dense ecological setting. This research was mainly focuses on the dense ecological green belt of Mahim -a village in Palghar located 8 km in parallel from Palghat railway station. This dense ecology consist of the coconut farmlands, which give the region a unique identity and character. This ecology act as a sensitive barrier edge between the coast and the city. The Wadval community people gain economy for this green belt, which is in the closes proximity to the future growth towards the edge of this ecology.

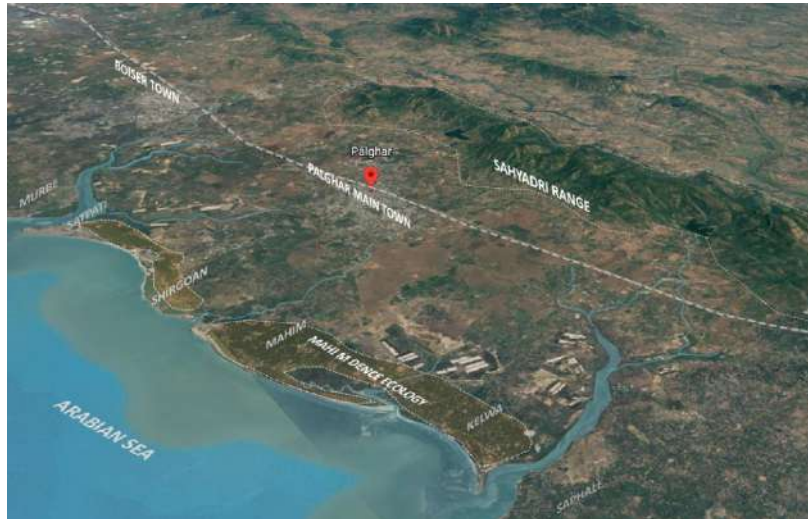


Figure 5: Palghar existing ecology with context setting Source:Author

The below table gives as approximate understanding about the dense plantation of coconut farmlands and the production of nuts over the year which is a huge figure to look at which this rich ecology is providing the community for their growth.

Total Coconut Plantation Area	~ 3149420.4 SQ.M
100X100 grid i.e 10000 SQ.M Area	~110 coconut trees
Total coconut trees in 3149420.4 area	~3149420 coconut trees

Table 2: Coconut plantation area and no of trees Source:Author, Research

No. of trees in mahim	Annual nut yield/ palm	total nuts	~ average nuts/ year
~3149420 coconut trees	150	472413000	472413000

Table 3:No. of coconut production Source:Author, Research

This ecology of coconut if expanded in paralleled to the existing ecology ,from the village of kelwa to the tip of shirgoan forming an ecological belt, it will impact the economic growth that will uplift the community, the climate and atmosphere will become more clean and a new sector of economy - tourism will flourish. The conservation and expansion of the ecological belt will influence, social, economic and environmental boom to the urban expansion city of Palghar.

7. Coconut based economy:

The total world production of coconuts in 2020 is predicted to be 61,520,382 metric tonnes, a 1.0% decrease from 62,159,626 tonnes in 2019. The Philippines, Indonesia, and India generate over 70% of the world's total copra, with the Philippines and Indonesia also being the world's leading exporters of coconut oil. Kerala, Karnataka, Tamil Nadu, and Andhra Pradesh produce the majority of India's coconuts, accounting for 89.13% of the country's coconut land and 90.04% of its coconut production.

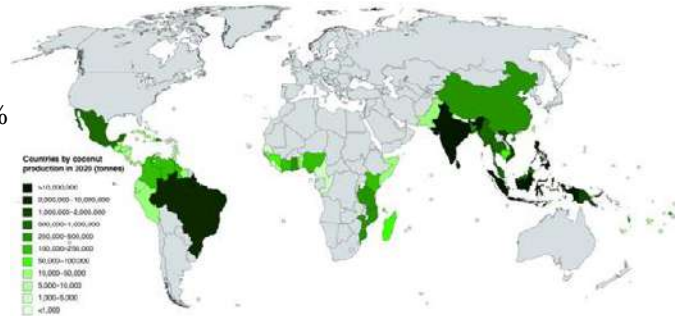


Figure 6: Coconut growing countries
Source: International coconut board

1. Inflorescence Based:



2. Water Based



3. Kernel/MeatBased



4. Husk Based



5. Leaves Based



6. Shell Based



7. Trunk Based



The possibility of using coconut tree and nut are unlimited. The scope of economical generational are huge. Mahim Coconut plantation are about ~3149420 coconut trees spread across ~ 3149420.4 SQ.M, which the community can use and setup the skills to use this rich resource efficiently. This show how existing ecological setting in the region can benefit the future need of the community with the urban growth and build a region that is not rural or urban but an rurban having both bind together to uplift the people and hence the city.

8. Conclusion :

Global risk have demonstrate the deconstruct the ecology during the next ten years. With globalization and digitization the aspiration of people have affected the understanding of importance of ecology and the character is vanished, making the rural space to be monotonous like the city with no regional identity and no sensitive planning and policy making.

In the town of Palghar which is at verge of becoming a city with larger urban growth and upcoming infrastructural development, the regional administrative body should make a step wise planning policy that helps the city to grow. Considering the ecological setting of the region that have full potential to give the emerging city an economical support with help of ecological expansion .we live in the worlds of binaries of urban and rural ,rich and poor that create gap in the regional setting and society as well. Methology should be adopted and guidelines should be made considering the community and ecology that will benefit the people who are part of this environment.

Following points should be step wise consider for the upliftment of community and economy.

1. Having a depth study and consideration of ecological setting.
2. Examination of the ecological setting along with the community that are depended on that resource and aware people about the importance of the ecology and the ways to use them effective to generate economy.
3. Guidelines and zones should me make in the emerging town like Palghar were growing population and infrastructural project should sensitively build around the ecology and conservation policy of this ecology needed to be adopted.



Figure 5: conservation of existing ecology and expansion of ecological belt Source: Author

Lastly, Today's urban growth and, urban expansion have created a harsh effect on this ecosystem. In the context where there are so many rapid infrastructure project to be developed, the edge between the urban expansion and ecosystem need to be curial to look after .This ecological edge in the rurban context are the whole and soul of the context that has to be deal with sensitivity. The Eco zone in rurban context are the incubators of knowledge and skill based economy, wherein community groups can seek potential for economy growth with coexisting with the nature.

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10. List of figure :

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Figure 5: Palghar existing ecology with context setting Source: Author

Figure 6: Coconut growing countries Source: International coconut board

Figure 7: conservation of existing ecology and expansion of ecological belt Source:Author

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Table 3:No. of coconut production Source:Author, Research

Assessing built heritage, liveability, and sustainable urban development of Estado da India (Old Goa), a smart medieval lost Portuguese colonial capital in South Asia

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Abstract: *Estado da India*, a port city, a lost, smart medieval Portuguese peri-urban historic colonial capital, is a living embodiment of our diverse cultural heritage, traditions, architecture, sustainability, and social values. It is our responsibility to ensure that future generations have access to and connect with this heritage and to understand the livability and long-term value of past urban design and city planning. This paper aims to understand the heritage, liveability, and sustainability of the early modern urban landscape and colonial urbanism in South Asia from 1510 CE-1600 CE, a golden period of Old Goa. The research objectives are to understand conventional Portuguese medieval city structure as recreated in the colonies, evaluation, interpretation, and assessment of the livability and sustainable urban development of a medieval colonial capital, perception of city planning of Estado da India-Cartographic imagery of the city by correlating it with the cartographic maps of Old Goa from Itinerario by Jan Huygen van Linschoten's, 1596, Plantaforma by Manuel Godinho de Eredia, 1620 and Descricao da Fortaleza by António de Mariz Carneiro, 1639. In understanding and contextualizing the city's urban design and planning, form, fabric, architecture, infrastructure, socioeconomic, political, and defense processes in the town of Old Goa, a literature review of archival and published historical accounts provided informative and explanatory substance. For research methodology, a snowballing method adopted for the study, mainly based on published data supported with the help of maps and drawings derived from the Crown, Government officials, missionaries, travelers during that period and endorsed by a site study. The study is broadly classified into archival and field research. The research seeks to look into heritage as a significant component of quality of life, liveability, and sustainability as a contribution to the social well-being of society. Elements of townscape, built spaces, unbuilt spaces, street patterns, and biological determinants such as land, water, and vegetation give a city its distinct personality and provide the sense of belonging essential to cultural identity, built heritage, and sustainability in a smart city. Today, the word smart for a city is coined for liveability, economic ability, and sustainability. In terms of originality, value, and implication, the research paper provides a new contribution and insight toward making a point that our five-hundred-year-old ancient inheritance, heterogenous culture, and heritage cities give us an insight into humankind and that they were livable, sustainable, and smart.

Keywords: Built Heritage, Culture, Liveability, Urbanism, Sustainability

1. Introduction

Heritage is more than just monuments. Heritage, both cultural and natural, tangible and intangible, is a growing resource that promotes identity, memory, and a "sense of place." It is crucial to achieving sustainable development. It fosters social cohesion, encourages socioeconomic regeneration and poverty reduction through infrastructure services and investments, promotes the expansion of cultural

and creative industries, creates jobs, improves social well-being, and boosts regional appeal and long-term tourism advantages. It is imperative that we address the issue of preserving this fragile, non-renewable resource for current and future generations (ICOMOS, 2011a). ICOMOS, the agenda for goal 11, Sustainable Cities and Communities, is one of 17 Heritage and Sustainable Development Goals, which discusses making cities and human settlements inclusive, safe, resilient, and sustainable.

India's cultural heritage is world-renowned. Mainly, it is archaeological and constructed heritage. India has one of the most extensive geopolitical expanses and one of the most comprehensive and diverse heritages. This immense treasure of Indian heritage is recognized globally as an essential aspect of India's distinct cultural identity. Historically, India was a blending of different civilizations and cultural exchanges, resulting in a vast archive of settlements, places, and monuments with diverse art and architecture dating from various historical periods. This tradition of fusion and absorption of ideas and beliefs enables India to stay earthy and be the basis of cultural diversity while sharing linkages with many regions such as Africa, the Arab world, Asia, Europe, and others worldwide (NITI Aayog, 2015).

Europeans have inhabited India since antiquity. Vasco da Gama discovered that several Italian mercenaries were already working for various kings on the Malabar Coast when he first arrived in India (Malekandathil, 2010). The first European to establish a foothold in India were the Portuguese. The crucial location of Goa along the Arabian Sea, nearly in the center of the prosperous provinces of Gujarat and Malabar, drew the Portuguese in. Fleets from Goa could have governed trade between the two areas, and the land base could have supplied enough water and food for the trading port. The Portuguese took over Goa in 1510 CE. The Portuguese estate of India, also known as Estado da India, was established as the capital city (a title established by Morques de Pombal in 1758 to distinguish Goa, Daman, Diu, Dadra, and Nagar Haveli) (Wilson et al. 2013) had established maritime supremacy controlling East Africa to Malacca in modern-day Malaysia and Macao in China by 1530 CE.

The dynamism of city development was wealth generated from trade. The Portuguese generated enormous wealth from maritime trade, and the surplus was diversified towards the urban construction of Old Goa. The new city was designed for controlling trade over Europe, Asia, and Africa. The Portuguese rulers' city space, development, and town growth were destined for their political interest, followed by power due to wealth, and showcased the city as a power center in the Asian context. Due to the above factors, the evolution of city design was subjected to recurring addition and alteration over the years (Malekandathil, 2009). This is reflected through meticulous space design and architectural formatting. The city's development had an adverse effect when Portugal was affected due to the fall in trade by the end of the 16th century due to other establishments like the Dutch, British and French in the Asian region.

Historic urban areas promote social inclusion, cohesion, and well-being. They are distinguished by their human scale, walkability, vitality, and variety of functions and public spaces. The shared use of streets, open and green spaces, and the entire historic urban landscape, as well as the inherent interdependence of the public and private spheres, can encourage engagement, exchange, and integration among diverse populations and between existing and new people (Labadi, 2021). The purpose of this paper is to evaluate the culture and heritage value and the sustainability of urban development of Estado da India (Old Goa), the early modern urban landscape, and colonial urbanism in South Asia from 1510 CE-1600 CE, a golden period of Old Goa. The objectives are to evaluate the abandoned capital's ecology, land use, and settlement pattern by correlating it with the cartographic map of Old Goa from Jan Huygen van Linschoten's Itinerario, 1596, Manuel Godinho de Eredia in his Plantaforma da Cidade de Goa – Livro de Plantaforma das fortalezas da Índia, 1620 and António de Mariz Carneiro in 1639 contained in his Descricao da Fortaleza de Sofala e das mais da India. A snowballing method is used, in which a research paper is read, and the references documented are then examined. The methodology is on the basis of available archival data from Goa archives, online, downloaded archival materials, published transcripts supported by maps, drawings, and sketches from the Crown, Government officials, missionaries, and travelers. Validating historical interpretation,

prose, poetry, art forms, historical information, and site study. The study is divided into two parts: archival research and field research.

2. The conventional Portuguese medieval city structure as recreated in the colonies

The Portuguese medieval colonial city development in the conquered regions followed a pattern. The various natural conditions under which Portuguese overseas colonies were structured, the many cultures they encountered, and the unique responsibilities they were assigned, gave each a distinctly regional flavor. Portuguese conquest shared the same models of connection, primarily drawn from Lisbon, the metropolis, giving a distinct colonial identity. Portuguese colonial colonies were strategically placed along the coast to service and secure sea channels or to access crucial trade routes. They were built on hilly soil whenever possible, continuing the castrensian tradition of fortification on high ground that reached back to pre-Roman times. The settlements were primarily defensive centers fitted to the land's topography; concerning people, urban spaces, climate, and geography; their primary goal was territorial control. Places with fortification were coupled with commercial activity on the coast or riverbank; they were divided into two layers: the dock and marine trading business near the sea level and the Governmental, primary institutional, and the majority of the dwellings on higher elevation (Teixeira, 1990). A straight path that ascended the hill and eventually became the settlement's main street, the so-called Rua Direita, linked the two sections. The best of the locations and the hilltops within the fortified area were the Viceroy's palace, Misericordia (the public assistance building), the hospital, the town hall, and significant religious buildings and convents were all located. These structures were well-built and gave the town a sense of community. They were also important in urban space organization. They, along with the randomly connected squares, became important locations for developing the urban tissue and the uneven courses of the streets that connected them (Teixeira, 1990).

3. Reading Maps, its significance and interpretation in context with Estado da India

Maps are physical records of a geographic area that convey city images. Maps provide a clear sense of what a town's colonial spaces could be and how these places work. During the peak of Portuguese political, marine trade and commercial prosperity in the Indian Ocean during end of the 16th century, resulted in the creation of the first representations, images, and maps. The city of Goa had significant urban development and housed a sizable population. As a result, the maps produced in 1596 are depictions of established Portuguese governance with explicit knowledge, experience, and expertise in designing urban environments (Wilson, 2015). The map creators or composers were colonial representatives who created work for the colonial authority and the Crown that reflected aristocratic imperial interest. The most well-known collection of maps is from 'Antonio Bocarro's Livro das Plantas de todas as fortalezas. In 1632, King Filipe III of Portugal appointed Bocarro as the Estado da India's chief archivist and official chronicler. Bocarro's maps were completed and authentically handed to the Crown. Other mapmakers associated with the Crown were Antonio de Maris Carneiro, Portugal's senior cosmographer, in 1631. Consequently, the maps are linked since they were created for colonial or royal governance use. Thus, maps connect directly to their in-house engagement and interpret the urban places, form, and fabric of the city of Goa (Wilson, 2015).

Jan Huygen van Linschoten created one of the first recognized maps of the city of Goa. A Dutch immigrant visited Goa and documented his experience in his well-known Itinerario (Linschoten 1997). Linschoten's thorough discoveries during his trip to India and layover in Goa as an accountant to the Archbishop resulted in the map. This map presents an image of Goa at its pinnacle of Portuguese political, trade, and commercial power in the Indian Ocean. Typical city maps from this period display metropolitan areas in depth and detail while leaving the underdeveloped area unaffected or accentuating outlying areas by natural characteristics (Santos and Mendiratta 2011). The notion of urban space in these maps consists of generally close-knit clusters of previously erected stone dwellings, market areas, administrative buildings, religious edifices, and cultured landscape open spaces distinct from rural/agricultural spaces in the periphery. Looking at Goa's city maps, one notices that the city spaces are very manicured and precise, whereas the surrounding countryside is

not well plotted. This map helped in perceiving the city's form, fabric, texture, and image during its peak, as there was not much evidence now except a few heritage churches of the lost city.

4. Perception of city planning in the context of Estado da India-Cartographic imagery of the city

The planning features the large outer fortification wall constructed between 1566 and finished sometime in the mid-17th century (Wilson et al. 2013). The city design began with four enormous complexes along Mandovi's southern bank, which included the metropolis' administrative and economic operations. The Ribeira Grande, the city's workshop, upstream, with the arsenal, foundry, dockyard, mint, Vedor da Fazenda (Controller of the Treasury). The Cais de Santa Catarina east of the Ribeira Grande included a fishing boat landing facility and a fish market. Archbishop's prison abutted the Ribeira Grande wall, where victims of clerical anger were imprisoned. The Jesuit-run Great Royal Hospital and the Chapel of St. Martin occupied the southern side. Ribeira das Gales is a smaller property east of Cais de Santa Catarina. Beyond this line was the Ribeira's prominent feature, the Quay of the Viceroy a landing site for arriving commodities. The Alfandega, or Custom House, the Bangacal, or go down for cargo, the Peso, or weigh-house. Towards the south of these main four compounds and the Grande Bazaar the town of Goa was located (Cabral 2001), (Fig. 1- Cartographic imagery of the city). It was reached by the famed Viceroy Arch on the Viceroy's Quay. Through this doorway, one entered the Terreiro do Paco, or Palace Square, which was flanked on one side by the south facade of the Palace and the Palacio da Relaco, the High Court, and was Goa's smart happening place for the *Fidalgos*. From the Arch of the Viceroy, Rua Direita, or Straight Street, flowed through the square. The Santa Casa da Misericordia, a philanthropic organization, was about halfway down this mile-long road. O Leilo, the auction was held on the street between the Terreiro do Paco and the Misericordia. This included a horse market and a slave market. Pyrard characterized this street as elegant and broad, with shops owned by goldsmiths, precious stones, silk mercers, weavers, and skilled craftsmen, the richness of the Indies and the most exquisite, jewellery could be found here (Pyrard, 1619). A little distance to the right was the Cathedral Quarter, with Goa's most prominent architecture. The Inquisition edifice extended to O Leilo on the left side. The Cathedral of St. Catherine stood on the square's western edge (Boies, 1960), (Rossa, 1997).

To the left and across the square was the Senate House, where the municipal administration convened, coming after was Casa dos Contos (Treasury), here the finances of the Estado da India were governed. The Archbishop's Palace, a simple, dignified two-story structure built in the 1560s and still standing today, stood between this and the cathedral. The Convent of St. Francis of Assisi, founded in 1517, among one of the earliest Christian religious building in Goa and the main center of operation of the Franciscan order in India. A modest Chapel of St. Catherine stood next to it was established by Albuquerque immediately after Goa's conquest on November 25, 1510, and was the earliest Christian shrine in Goa. The Misericordia, one of Goa's prominent buildings and an orphanage, was reached by returning to Rua Direita and walking down to it. The beautiful Nossa Senhora da Serra chapel stood next to the Misericordia. The Pelourinho Velho, popular as the ancient pillory, a vast square to the south of this cathedral on the Rua Direita. Offenders were uncovered and sentenced to have their hands severed. A lively market was positioned at the intersection of six streets. The *Rua Direita* extended for a few yards past the smaller Pelourinho Velho square staying commercial before coming to an end to the church of N. S. da Luz, marking the city's southern boundary. (Cabral 2001), (Rossa, 1997).

Among the fifty or so churches, convents, and organizations that contributed to Goa's ecclesiastical community establishment, the following are a few of the most important. The College of St. Paul is a ruined Portuguese theocracy remnant in the city's southeast. The Convent and Bom Jesus Church across Pelourinho, a notable Jesuit institution that housed Francis Xavier's remains. The Terreiro de Santo António, atop Monte Santo, the Sacred Mount, was reached via Santa Mónica, a short distance west of the Terreiro dos Galos. St. Augustine's Convent, the Augustinians' primary east seat, stood across the square. This convent was said to be the most magnificent and well-built structure in all of Portuguese India. (Cabral 2001)

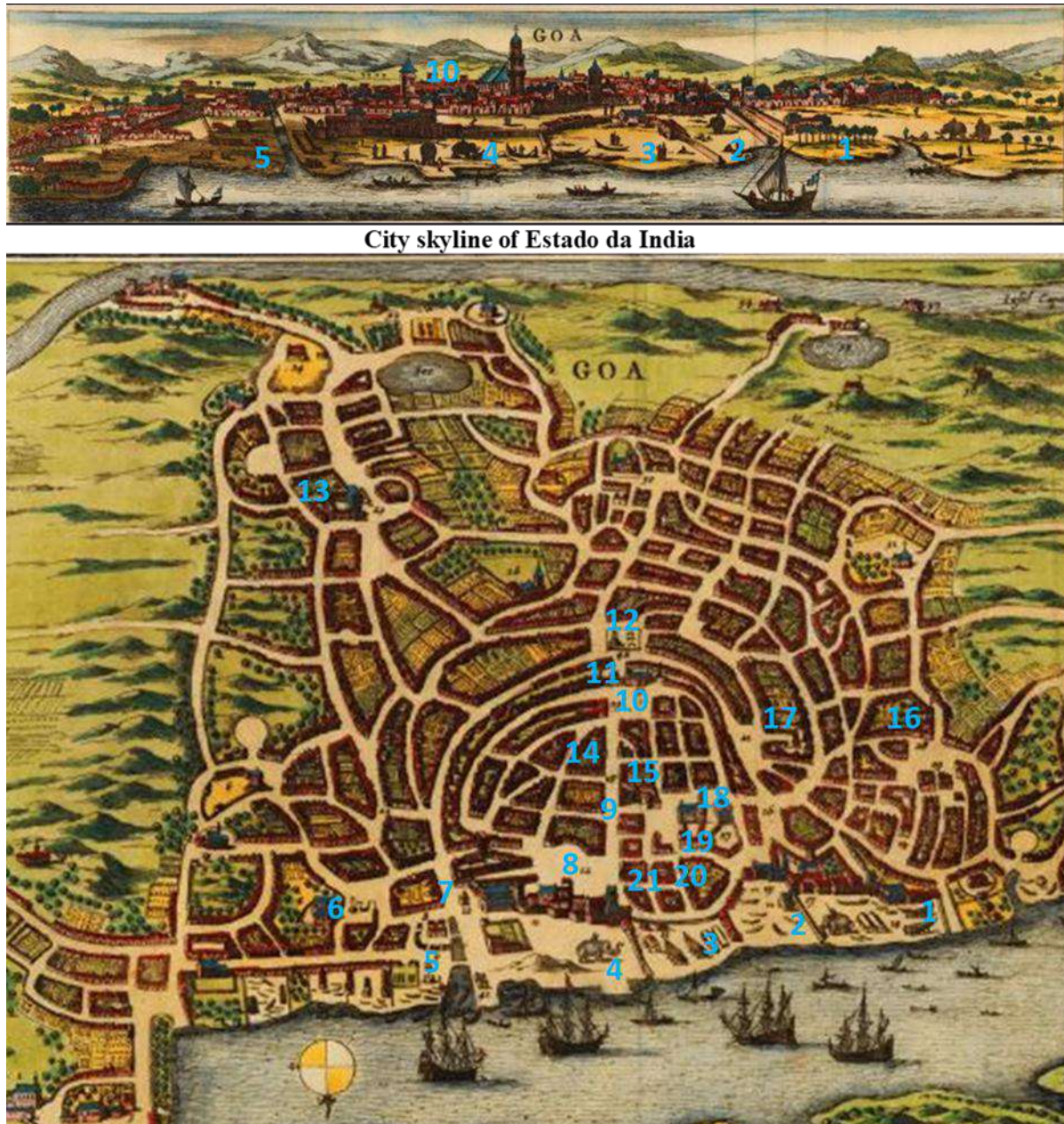


Figure 1. Perception of city planning in the context of Estado da India-Cartographic imagery of the city

Source: Map of Velha Goa by Jan Huygen van Linschoten first published in 1596 in his Itinerario.

- | | | |
|--------------------------------|--|----------------------------------|
| 1. <i>Ribeira Grande</i> | 9. <i>Rua Direita</i> | 17. <i>Church of Bom Jesus</i> |
| 2. <i>Cais Santa Catarina</i> | 10. <i>10.Casa da Misericordia</i> | 18. <i>St. Francis of Assisi</i> |
| 3. <i>Ribeira das Gales</i> | 11. <i>Church of N.S. Serra</i> | 19. <i>Archbishop's Palace</i> |
| 4. <i>Quay of the Viceroy</i> | 12. <i>Pelourinho Velho</i> | 20. <i>Casa dos Contos</i> |
| 5. <i>Bazaar Grande</i> | 13. <i>College of St. Paul</i> | 21. <i>Senate House</i> |
| 6. <i>Church of St.Dominic</i> | 14. <i>O Leilao</i> | |
| 7. <i>Arch of the Viceroy</i> | 15. <i>Building of Inquisition</i> | |
| 8. <i>Terreiro do Paco</i> | 16. <i>Santa Monica and Convent of St. Augustine</i> | |

5. Interpretation and assessment of sustainable urban development of Estado da India a medieval colonial capital

Analyzing the city form and fabric from these maps and field studies the components of the European medieval towns can be read and understood. In textbooks on the history of urban design by Morris A E J, the five elements of medieval towns are the fortified city walls along with watch towers and defense gates; Streets, market and commercial places; the Church square and town buildings and related open spaces (Morris,1994). From the cartographic data, these can be assessed. Also, if one looks into the medieval era these five components in medieval towns were sustainable in terms of their contribution to the social well-being of the society, and quality of life. Elements of townscape, built spaces, unbuilt spaces, street patterns, and biological determinants such as land, water, and vegetation give a city its distinct personality and provide the sense of belonging essential to cultural identity, built heritage, and sustainability in a smart city.



Figure 2. Map showing fortification wall, edifices, and street pattern

Red Block indicates Gates- To the East is Fortress gate and to the West is River Gate

Source: Descricao da Fortaleza by Ant3nio de Mariz Carneiro



Figure 3. City pattern and fabric for the layout of the capital city indicating organic and planned grid iron pattern

Red Block indicates the Organic-Radial Pattern of City Development as per Topography. Yellow Block indicates Planned-Grid Iron Pattern in Coastal Plains

Source: Plantaforma by Manuel Godinho de Eredia

The maps reveal little about urban form; the map does not offer a precise portrayal of the city or the features of buildings or other urban infrastructure. It denotes the placement of churches, offers a basic street layout, and denotes the location of the port, quay, and outer fortification wall. Furthermore, these maps frequently provide a more realistic picture of the surrounding shoreline and forts. The basic layout of main streets, the position of fortifications, and the port are all crucial from a military and economic standpoint, undoubtedly the Crown's principal priority. According to Cottineau De Kloguen, the city was three-fourths of a mile long and a quarter-mile wide at the time of the conquest, and it was already a thriving and cosmopolitan trade entrepôt attracting merchants from across the Indian Ocean and beyond (Kloguen 2008).

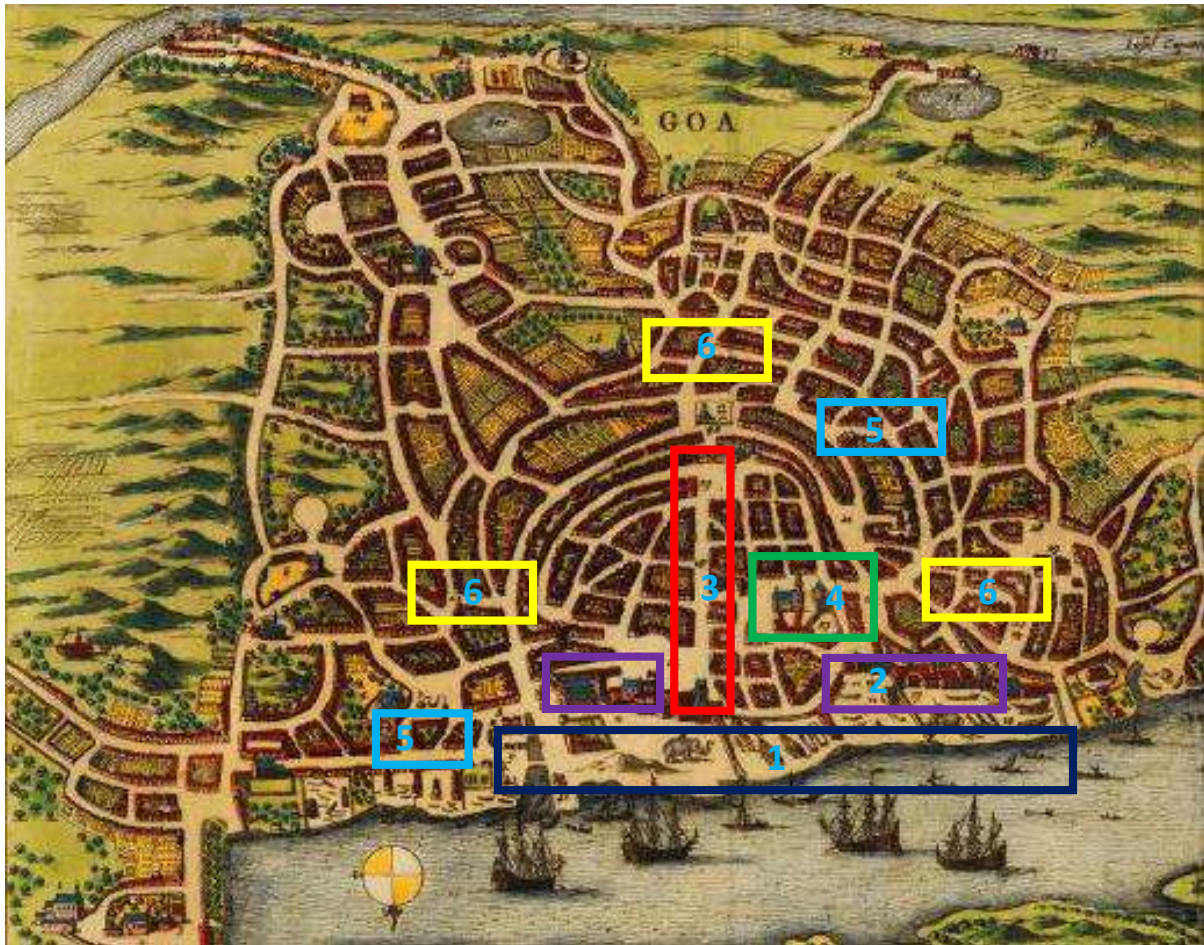


Figure. 4. Showing land use pattern of Old Goa, the capital city

Source: Map of Velha Goa by Jan Huygen van Linschoten first published in 1596 in his *Itinerario*

1. Dark blue indicates military, trade, and industrial land use
2. Purple indicates administrative and public land use.
3. Red indicates commercial and marketplace land use.
4. Green indicates church square.
5. Blue indicate religious and institutional land use.
6. Yellow areas are streets, residential land use, agriculture, and open spaces

Map from *Descricao da Fortaleza* by António de Mariz Carneiro, 1639. showed fortification walls, towers and gates, edifices, and street patterns in the context of continuing tensions with the surrounding Muslim Sultanates during the early phase of the Portuguese occupation of 16th century Goa, associated with the maritime focus of the Portuguese *Estado da India* (Santos and Mendiratta 2009), (Fig. 2- Map showing fortification wall, edifices, and street pattern). 1596, *Plantaforma* by Manuel Godinho de Eredia, revealed that the city's layout consisted of the gridiron and radial patterns that followed the terrain topography and slopes, a characteristic of medieval colonial settlements (Fig. 3. City pattern and fabric for the layout of the capital city indicating organic and planned grid iron pattern). The *Rua Direita* ran through the city's institutional area, as well as the *Estado*. The remaining streets were organic radial in shape and lined with Portuguese-style masonry houses with courtyards behind, sometimes two-storied, tiled roofing, oyster shell window panes, pastel shades, and white

paint. There were most likely many more modest residences and agricultural lands within the settlement (Wilson 2015). (Rossa 1997). When the Cidade was elevated to the position of town in 1518, it was ruled by a municipal council made up of voted members of the urban establishment and merchantile prevealed, who wielded significant power over the city's development (Malekandethil 2009).

A marketplace is a place of commercial activity, either individual, near the Church square, or associated with streets. In the capital city of Goa, the grand bazaar experienced a chaotic move. The streets were well paved and maintained. Two floored shops and the residences were constructed of laterite stone and lime mortar, lime plaster finish, and a sloping roof of handmade country tiles. The general design of shopping spaces was ground floor shopping and upper floor residences (Cabral 2001). The Church Square is an independent space formed in front of the Church, a community space where people assembled for social and religious activity. A lane turned west halfway down Rua Direita in Goa's capital city, leading to the square of the parish church of St. Catarina. The Church, at present known as the Se Cathedral, was elevated to the status of a Se (cathedral of a bishop) in 1534 when Goa was raised to a bishopric, and then rebuilt to grandeur proportions (1564-1652) when Goa became an archbishopric. The Franciscan Convent and the Church of Espirito Santo (Holy Spirit) were nearby (Rossa, Mendiratta 2011).

The town had a color scheme of pastel shades. It was painted with a wash of indigo, brown, yellow ochre, red, etc. Glass was hardly used. In place of glass, polished oyster and kapitz shells, filigree, and jalli work were used for windows for the entry of light and for the ladies to see outside without being exposed to outside. The upper stories had balconies to exchange the air in the humid and warm coastal climate. The houses had open spaces in the backyards with native fruit-bearing trees. The landscape of the streets and the built spaces gave a country look to the skyline of the capital city of Goa (Guedes Pedro et al.2012).

From the literature and archival study and the structural remains and a generally high degree of visibility of archaeologically significant remains, including standing architecture, foundations, fortifications, and infrastructure, one can conclude as follows: There are five significant layers in the urban design of the capital town or land uses. 1. Military, trade, and industrial land use, 2. Administrative and public land use. 3. Commercial and marketplace land use. 4. Church square, religious and institutional land use, and 5. Streets, residential land use, agriculture, and open spaces (Fig. 4. Showing land use pattern of Old Goa, the capital city).

6. Conclusion

The first Europeans to establish a stronghold in this part of the subcontinent were the Portuguese. They understood the geo-political importance, defense, and military significance, and the geomorphological relevance of land, water, and vegetation the settlement development and growth. The Portuguese were drawn to Goa because of its strategic location on the Arabian Sea, almost in the middle of the prosperous provinces of Gujarat and Malabar. Fleets from Goa could have governed trade from both areas, and the hinterland could have supplied the base with enough food and water. The first thought of sustainable development was the location of a capital city.

The city's layout consisted of grid-iron and radial patterns that followed the terrain topography and slopes, giving importance to ecology and also a characteristic of medieval colonial settlements. The *Rua Direita* ran through the city's institutional area, as well as the *Estado*. The remaining streets were organic radial in shape and lined with Portuguese-style masonry houses with courtyards behind, sometimes two-storied, tiled roofing, oyster shell window panes, pastel shades, and white paint increasing liveability, social inclusion, cohesiveness, and well-being.

The architecture and urban design of the city confirm the theories and principles of urban design laid down by A. E. J Morris. The study depicts that all five elements of the urban form of medieval European cities are present. The city form consists of fortified city walls, watch towers and defense gates; Streets, markets, and commercial places; the Church square, town buildings, and related open

spaces. All these were designed at a human scale, reachable within a walkable distance, promoting walkability and making the town user-friendly and sustainable.

All the available maps reveal a conceptualization of urban space as an object that consists of a civilized place of ecclesiastical and administrative power symbolically embodied in monumental edifices, formally built stone homes, particular architectural styles, an organized and rational street pattern, open spaces, and which ultimately took Lisbon as its primary point of reference and socio-spatial model. This gave the city its distinct personality and provided the sense of belonging that is essential to cultural identity and sustainability.

Finally, there are five significant layers in the urban design of the capital town or land uses. 1. Military, trade, and industrial land use, 2. Administrative and public land use. 3. Commercial and marketplace land use. 4. Church square, religious and institutional land use, and 5. Streets, residential land use, agriculture, and open spaces. These contribute to the social well-being of society and are regarded as an important constituent of quality life. The use of street patterns, open spaces, past urban landscape, as well as the inherent interdependence of the public and private fraternity, encourage engagement, sharing, and assimilation among diverse populations and between existing and new people.

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Nature – Culture association of Saptarishis in India

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Abstract: India is a land rich with stories of legends, myths, heroes and philosophers. These myths and legends developed in this land are intertwined with its Natural elements such as Mountains, Rivers, lakes, trees etc forming a Sacredscape. The concept of Indian Sacred Landscape is complex and explores the foottraces of Pilgrims throughout the landscape. It signifies continuity and Spatiality of time and scarlity of nature resulting into a sacred conscious landscape. The concept of Sacredness cannot be separated from the idea of Geography. The landscape reflects how the micro i.e., the concept of divine in the mind of a person is reflected in the macro i.e., imagined into the surrounding natural landscape bridging the gap between the two. This interplay resulted into a continuous development of the regions identified or rendered as sacred and eventually become important pilgrimage centres. The manifestation of these myths into tangible resources and intangible rituals forms a Sacred landscape which is evolving and continuous reflecting the relation between man and nature. For the study in this research the Saptarishis of this Manvantara i.e., the period of the current Vivaswat Manu is selected and explored. Saptarishis were the part of Vedic society flourished in the Gangetic plains. They were the Teachers, Philosophers, kingmakers and catalysts of change in the society. They are attributed to writing many versus in Vedas and other text evolved during this period. The myth and legend of the Rishis developed in Puranic stories and in epic like Ramayana and Mahabharata. The study explores the selected myths associated with the Saptarishis and the pattern of their manifestation throughout India the outcome reflects the cultural landscape of Saptarishis and the influence of Natural resources in the manifestation.

Keywords: Saptarishi, sacredscape, Nature – culture association

1. Introduction:

The *saptarishi* are considered as the sages instructed by Brahma to spread knowledge on earth. They are to assist mankind and bring knowledge to society. The story of these *Rishis* is associated till date and a pattern of stories and the core values are always to give a moral to the society. These stories are now considered myth finds mentioned in various *Puranas* and epics. It is considered that we are now on the 7th *Manu* of this *Kalpa* known as the *Vaivasvat Manu* who is also considered as the son of Surya. The present *Manu* is also known as Shradhdheva and has *Purandara* as present Indra. The present *saptarishi* mentioned in this period are Vashishta, Kashyapa, Atri, Jamadagni, Gautama, Vishwamitra, and Bharadvaja. The research will be focused on important mythical events and the stories associated with these *saptarishi*. Further, it will focus on the spatial manifestation of these mythical events into natural spaces and tangible entities like literary works, sacred spaces, etc.

2. Role of Saptarishis in Vedic society

The stories of the period of the *Manu* and the *saptarishi* is related to flood myths mentioned in *Vishnu Purana* where the *saptarishi* save the existing knowledge and educate mankind after the flood resides. The mention of *saptarishi* can be seen since Vedic time as they are attributed to composing many verses of the four Vedas. They are also considered Philosophers, scientists, and Teachers. The role of the *Rishis* was to bring about the material change and inner consciousness amongst their disciples to further propagate values of life. The *Rishis* have titles of *Brahmarishi*, *Maharishi*, and *Rajrishi* according to their role in the society whereas *Brahmarishi* is the highest title attained by them. We can also see the consorts of these *Rishis* and their origin stories are as powerful as the *Rishis* themselves. (Burgess and Gangooly, Transltion of the Surya Siddhanta). The *Rishis* are considered as

Vedic *Rishis* who also have their roles in the Ramayana and the Mahabharata. The concentration of the *Rishis* in the Gangetic plains can be linked with the Vedic civilization that flourished in this region. Hence the stories later developed in the *Upanishads*, *Aranyakas*, and the epics are related to this region.

3. Spatial manifestation of the Myths associated with *Saptarishis*

3.1. Atri and Anusaya

3.1.1 Myth: Atri was a Vedic sage with the title of *Brahmarishi*. He was the first mention of him was found in Rigveda. He is accredited for composing hymns of Agni, Indra, and other Vedic deities in Rigveda. The fifth mandala in Rigveda is named after him. He was married to Anusaya who was Known for her *Satitva* and devotion for her husband.

The legends and stories about the sage developed in Ramayana and Mahabharata. The myths associated with *Rishi* Atri and his consort Anusaya is found in Chitrakoot *Mahatmya* and Ayodhya Kanda of Valmiki Ramayana. The first one is the origin story of the river where Ganga descended to earth in the form of river Mandakini in Chitrakoot during a severe draught because of the efforts of Atri and Anusaya. The second story mention in Ayodhya kand in Epic Ramayana where Rama visits Chitrakoot *Ashram* of the *Rishi* and Sita receives lessons of *Satitva* from Anusaya. This is the same place where Bharat approaches Ram with the news of their father Dashrath's Death and the coronation of Lord Rama took place here in the presence of all the gods and *Rishis*. (Shri Ramcharitmanas)

3.1.2 Manifestation: The place mentioned in these scriptures is located in Uttar Pradesh and is part of the northern Vindhya ranges. The menifestations of the myths can be seen here in the form of ghats and smaller temples along the river Mandakini. The Ashram of Atri and Anusaya and place marking the Ramanaya event like Bharat Milap. The place has religious value because of the association and forms cultural geography where the town is considered sacred.

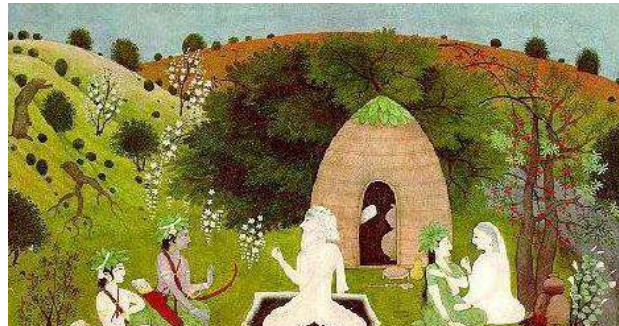


Image 1: Rama, Sita and Lakshmana at the Hermitage of Sage Atri. Source: Pahari School, Chamba kalam, Kangra idiom



Map 1: Map showing the sacred landscape of Chitrakoot
Source: Author



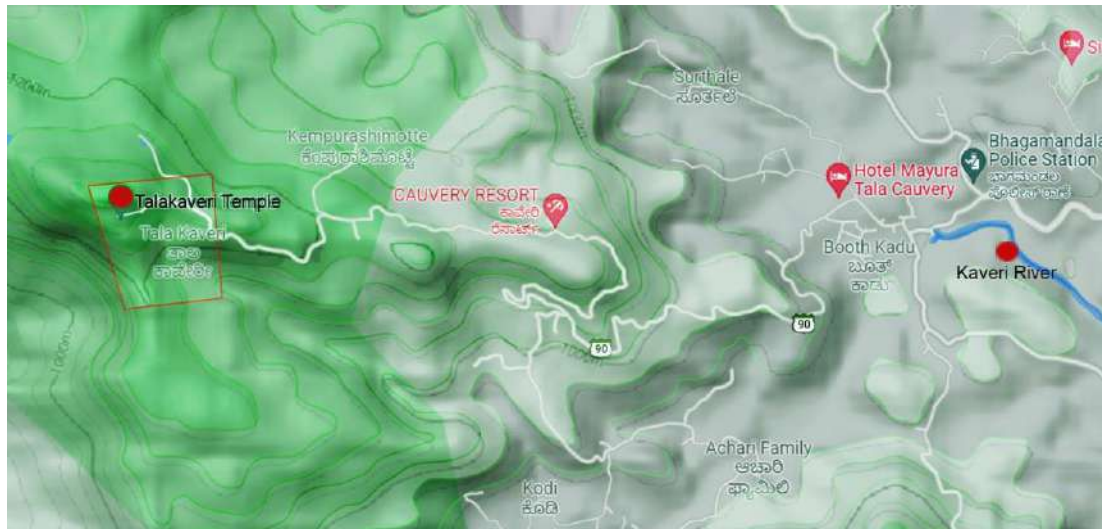
Image 2: Atri and Ahilya ashram near Mandakini River
Source: You Tube Video, Sati Anusaya Ashram, Uttar Pradesh – Chhattisgarh Rider

3.2. Agastya and Lopamudra:

3.2.1 Myth: Agastya was a Vedic sage with the title of *Brahmarishi*. He was first mentioned in Rigveda. Other mentions are found in Atharvaveda, Brahmanas and Aranyakas. He was attributed to writing Tamil Grammar and the author of Agastya Gita and Agastya Samhita. He was married to Lopamudra.

The legends and stories about the sage developed in Ramayana, Mahabharata, and the Puranas. One of the myths associated with *Rishi* Agastya and his consort Lopamudra is found in Kaveri Mahatmya where Lopamudra transforms herself into a river later known as Kaveri.

3.2.2 Manifestation: The place marking this event is known as Talakaveri and is considered as the place of the origin of River Kaveri. It is located at the Brahmagiri hill in the Kogadur district of Karnataka. The manifestation of the myth can be seen as a complex consists of Brahma Kundika or Tirtha Kundika the pond from which river Kaveri originated and adjacent to is a temple of Shiva to mark the origin. A temple of Shiva or Lord Agastheeswara is named after Rishi Agastya and is considered to be installed by Agastya. The other temple of the complex is of lord



Map 2: Map showing the Landscape of Talakaveri and Kaveri River, Source: Author

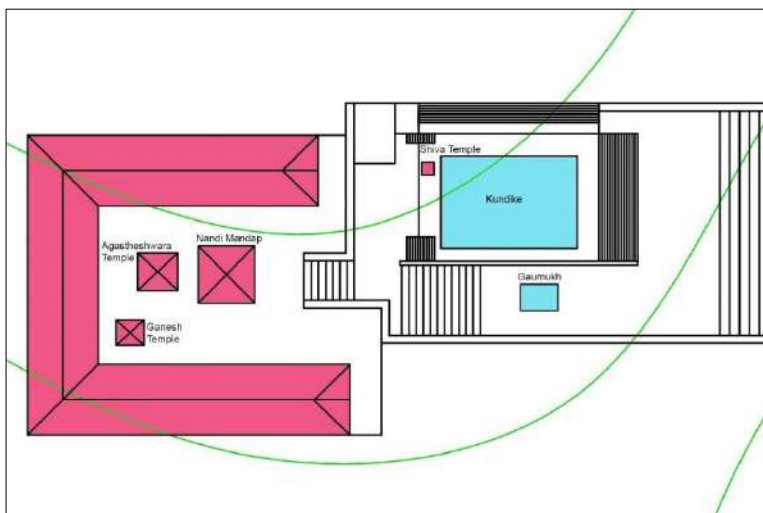


Figure 1: Plan of the Kaveri Temple complex (Representative Drawing Not to scale), Source: Author



Image 4: Agastheeswara Temple, Talakaveri Temple complex, Source: Trip Advisor



Image 3: Kundika of Talakaveri temple complex, Source: Coorg Tourism

Ganesha. (Mudde)

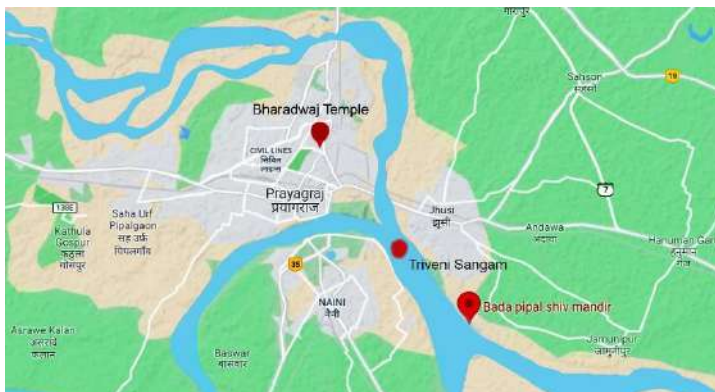
3.3. Bharadwaja and Susheela

3.3.1 Myth: Bharadwaja was a Vedic sage with the title Maharishi. He was a scholar, economist, Grammarian, Physician, and teacher. He contributed to verses in Rigveda and some treaties named after him are, Dhanurved, Bharadwaja Samhita, Niti shastra. He was married to Susheela and has a son named Garga and a daughter Devavarsini.

The legends and stories about the sage developed in Ramayana and Mahabharata. One of the myths associated with Rishi Bharadwaja and his consort Susheela is found in Valmiki Ramayana in Ayodhya Kand where Rama stayed overnight in Bharadwaj's Ashram before proceeding to Chitrakoot.



Image 5: Bharadwaj with Rama, Sita and Lakshmana, Source: Rajput Painting - Jaipur - 19 Century Vintage Indian Miniature Art from the Adhyatam



Map 3: Map showing the context of Triveni Sangam and Bharadwaj Ashram, Source: Author



Image 6: Bharadwaj Temple, Ashram site Temple complex, Source: prayagmahotsav.blogspot.com

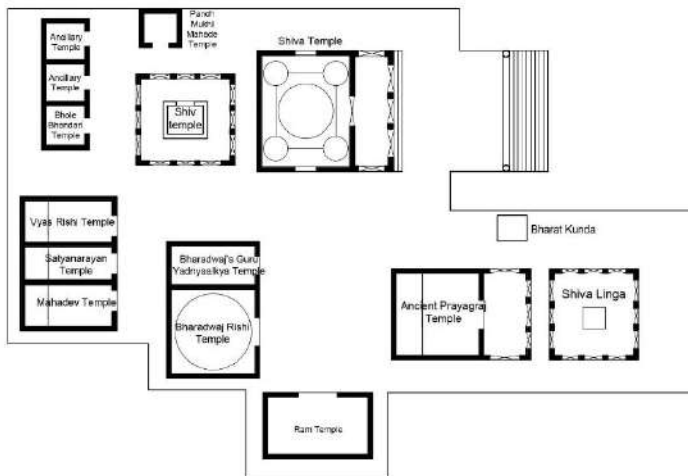


Figure 2: Plan of the Temple complex at the site of Bharadwaj Ashram (Representative Drawing Not to scale), Source: Author

3.3.2 Manifestation: The place marking this event is Prayagraj located in Uttar Pradesh at the confluence of three rivers Ganga, Yamuna, and Sarasvati. The place is famous for the Triveni Sangam and hence is considered as Tirtha Raj, the king of all Pilgrims. The manifestation of the event is the presence of the *Ashram* of Bharadwaja and Durvasa who taught 10000 disciples in this region. The sanctity of this place is associated with the references given in *Puranas* and *Ramayana*.



Image 7: Shiva Temple, Bharadwaj Ashram site Temple complex Source: Prayagraj social- Facebook



Image 8: Bharadwaj Rishi Temple shrine, Bharadwaj Ashram site Temple complex Source: Prayagraj social- Facebook

3.4. Gautama and Ahilya

3.4.1 Myth: Gautam was a Vedic sage with the title of *Maharishi*. His mention is found in Hindu, Jain, and Buddhist texts. He was married to Ahilya.

he legends and stories about the sage developed in Ramayana and Mahabharata. One of the myths associated with *Rishi* Gautama and his consort Ahilya is mentioned in the Valmiki Ramayana in Bala Kanda. Rama accompanied Vishwamitra to his hermitage at Tapovan to fight demons disturbing him during his Yajna. During this period Ahilya who was cursed by her Husband rishi Gautama and transformed into a stone was redeemed when lord rama touched his feet to the stone.

3.4.2 Manifestation: The place marking this event is Ahilya Asthan located at Ahiyari in the Darbhanga District in Bihar. The place is also called Ahilya gram. The manifestation is seen in the form of a temple of Ahilya and the shrine contains the footprints of Goddess Sita. The area has an Ashram of Gautam Rishi at Brahmapur and Gautam Kund.

Image 9: Ahalya emerges from her stone form, after being touched by Rama's foot. The motif of Ahalya being turned into stone first gets scriptural authority in the Puranas. Source: Early-20th-century print by Ravi Varma Press



Map 4: Map showing location of Ahilyasthan and Gautam kund, Source: Author



Image 10: Gautam Kund, Dharbhanga, Source: mithiladharohar.blogspot.com

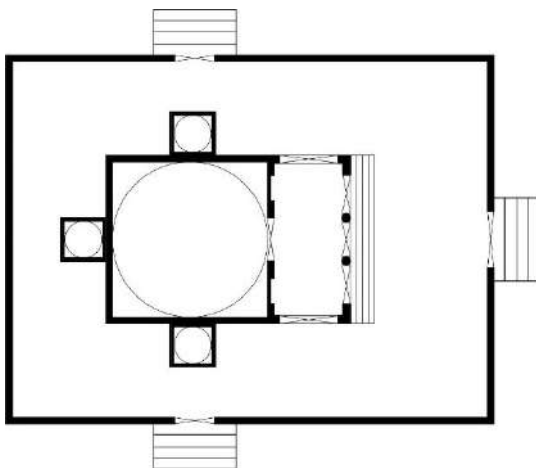


Figure 3: Plan of Ahilyasthan Temple (Representative Drawing Not to scale), Source: Author



Image 11: Ahilya sthan, Darbhanga, Source: mithiladharohar.blogspot.com

3.5. Jamadagni and Renuka

3.5.1 Myth: Jamadagni was a Vedic *Rishi* and the father of the 6th reincarnation of Vishnu Parshurama. He was the decedent of sage Brighu one of the *Prajapati* created by Brahma. He was married to Renuka and had 5 sons. The myth associated with *Rishi* Jamadagni and his consort Renuka is mentioned in the *Renuka Mahatmya*. In this myth Sahastrabahu kills Jamadagni over the possession of a divine cow Kamdhenu. Later Parshurama pledges to kill Sahastrabahu and performs the last rites of his father in Amlaki gram.

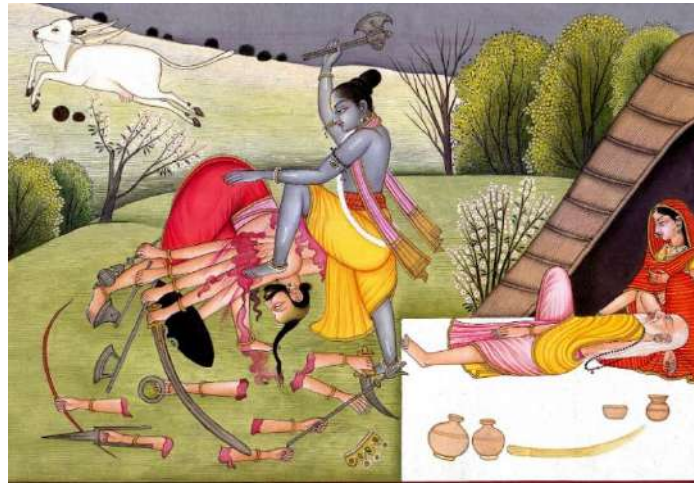
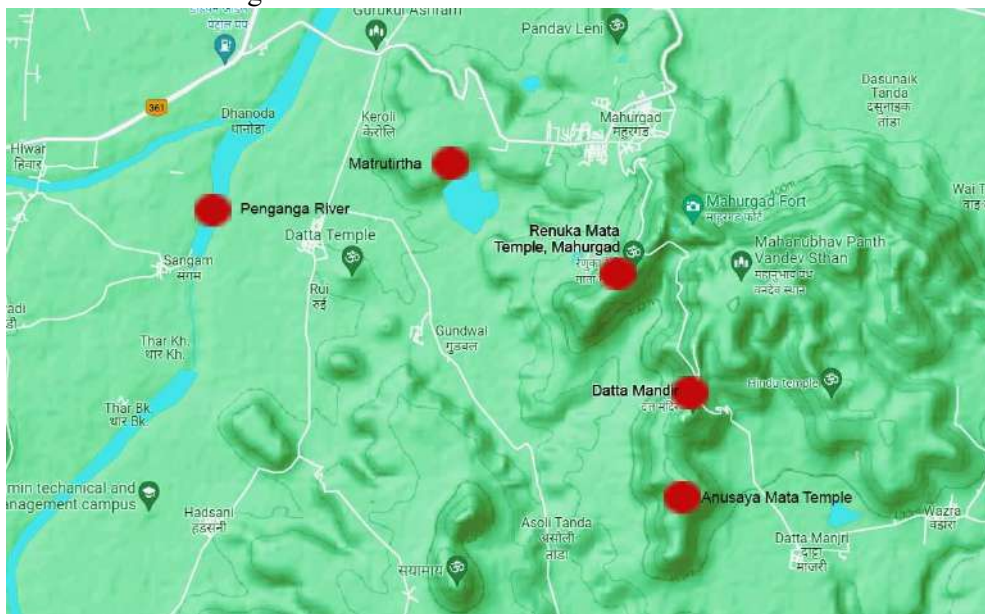


Image 12: Parshuram killing Sahastrabahu,
Source: Artist Kailash Raj



Map 5: Map showing sacred landscape of Mahurgad, Source: Author

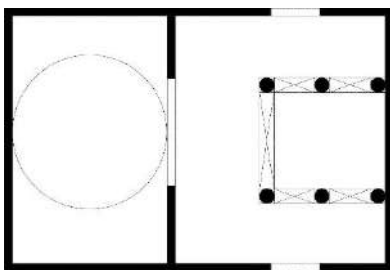


Figure 4: Plan of Renuka Mata Temple (Representative drawing Not to Scale), Source: Author



Image 13: Renuka mata Temple, Mahurgad, Source: temple.yatradham.org



Image 14: Matrutirtha, Mahurgad
Source: bp.blogspot.com

3.5.2 Manifestation: The manifestation of the event is seen in Mahurgad located in the Nanded district of Maharashtra. The manifestation is in the form of a temple of Renuka, Dattatreya, and his mother Anusaya is considered one of the Shaktipeeths of Maharashtra. It is part of the Sahyadri ranges the next place of importance is Matrutirtha where the water of all tirthas was collected by Parshurama and the temple of Parshurama at the foothills of the Renuka temple.

3.6. Vashishta and Arundhati

3.6.1 Myth: Vashishta is the oldest Vedic sage with the title *Brahmarishi*. He was also a *Rajrishi* and a teacher. He was the chief author of the 7th mandala of Rigveda and is called the sage of Vedanta school of Philosophy by Adi Shankara. Yog Vasishta, parts of *Agni Purana* and *Vishnu Purana* is attributed to him. He was the family priest of Raghu dynasty and teacher of Rama and his brothers. He was married to Arundhati.

The Myth associated with Vashishta and his consort Arundhati is mentioned in the Adi Parva of Mahabharata. The myth mentions the feud between Vashishta and King Vishwamitra who got defeated. In this event all of Vashishta's son was killed and he tried to end his life in a river but the river refused to kill him. (Roy)

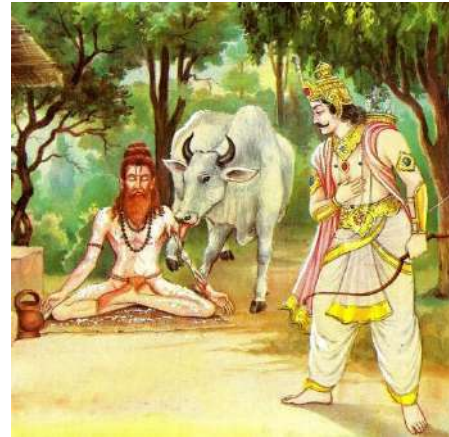


Image 15: Painting showing Vashishta, Nandini and King Vishwamitra, Source: sriramgurujala.com



Map 6: map showing the context of Vashishta Village, Source Author

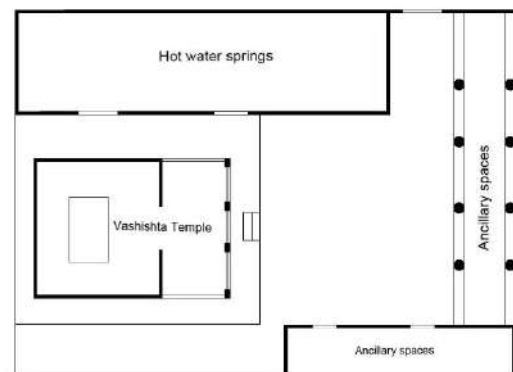


Figure 5: Plan of Vashishta Temple Complex (Representative Drawing Not to scale), Source: Author

3.6.2 Manifestation: The manifestation of the event is seen in Vashishta village a small place near Manali located near the Beas River. The village has temples of Rishi Vashishta and Lord Rama. There is a hot Sulphur spring near the Vasishta temple which was procured by Laxmana for his teacher for Bathing. The village is named after Vashishta.



Image 16: Vashishta hot water springs, Source: Solo traveler Sujit, you tube video



Image 17: Vashishta Temple, Source: Towno.in

Vishwamitra

3.7.1 Myth: Vishwamirta was a Vedic sage with the title of *Brahmarishi* and *Maharishi*. He was the author of 3rd mandala of Rigveda and Gayatri mantra. He was a king who renounced his kingdom and became a *Rishi*.

The myth associated with Vishwamitra is mentioned in the Valmiki Ramayana in the Bala Kanda.

Vishwamitra visited Dasharatha the king of Ayodhya and asked for Rama and Lakshmana to accompany him to his hermitage to kill the Rakshasa Marica since it was disturbing him in his Rituals.

3.7.2 Manifestation: The manifestation of the event is seen as Vishwamitra's *Ashram* also known as Siddh*Ashram* and Tapovan located in the Buxar district of Uttar Pradesh. It is located near the banks of the Ganga River. The place has a temple dedicated to Vishwamitra and the footprints of Rama in a cave. A ghat is built along the river known as Ganga ghat.



Image 18: Mareecha and Subahu fighting with Rama and Laxmana, Source: Geeta press



Map 7: Map showing context of Vishwamitra Temple and Ganga River,



Image 19: Vishwamirta Temple complex, Buxar, Source: in.worldorgs.com

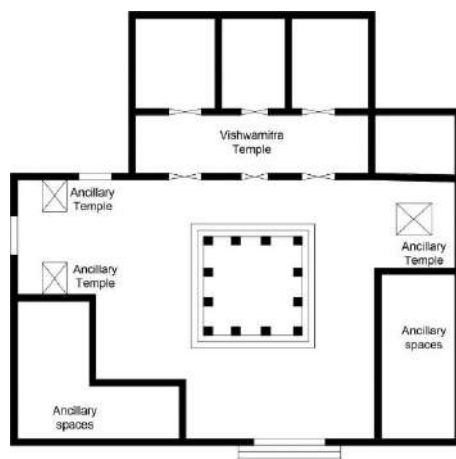


Figure 6: Plan of Vishwamitra Temple complex (Representative Drawing Not to Scale), Source: Author

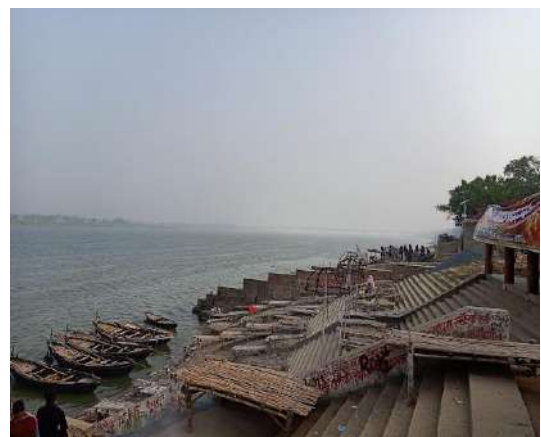


Image 20: Ganga Ghat, Darbhanga, Source: in.worldorgs.com

Table 1: Findings Table of Type of Manifestation

Sr no	Name of <i>Rishi</i> and their consort	Name of Associate d place	Type of manifestation			Level of manifestat ion	Photograph
			Associated Natural elements	Manifested Natural elements	Built forms		
1	Atri and Anusaya	Chitrakoot, Uttar Pradesh	Chitrakoot Hills	River Mandakini	Anusaya Mata Temple, Ram Ghat, Bharat milap, Spatik hill, Hanuman dhara	Regional	
2	Agastya and Lopamudra	Talakaveri, Karnataka	Brahmagiri Hills	River Kaveri	Talakaveri Temple complex with <i>Kunda</i>	Area level	
3	Bharadwaja and Susheela	Prayagraj, Uttar Pradesh	Triveni Sangam	----- --	Temple complex at the site of Bharadwaja <i>Ashram</i>	Area Level	
4	Gautam and Ahilya	Ahilyasthan, Bihar	-----	-----	Ahilyasthan Temple and Gautam <i>Kund</i>	Resource level	
5	Jamadagni and Renuka	Mahurgad, Maharashtra	Sahyadri hill ranges	Matrutirtha lake	Renuka Mata temple, Parshuram temple, Dattatreya Temple, Anusaya Temple	Regional Level	
6	Vashishta and Arundhati	Vashishta village, Manali	Beas River	Sulphur hot water springs	Vashishta Temple	Area Level	
7	Vishwamitra	Tapovan, Buxar, Uttar Pradesh	Ganga River	----- -	Vishwamitra Temple complex, Ganga Ghat	Area level	

In the Table Findings of Type of Manifestation, it is seen that the stories related to natural elements get manifested on the Regional and Area level whereas the places marking the Myths get manifested on the Resource level. The common element in these myths is a natural element which is the part of the myth or the origin story of the natural element itself. Though the map no. 8 it is derived that the

concentration of the majority of spaces is in the North at the Gangetic planes. The spaces related to Agastya are only seen in the southern part of India as described in Mythology that he migrated south. There are certain places associated in the central part of India, as described in myth those places developed when the *Rishis* migrated towards the center in search of Virgin land.

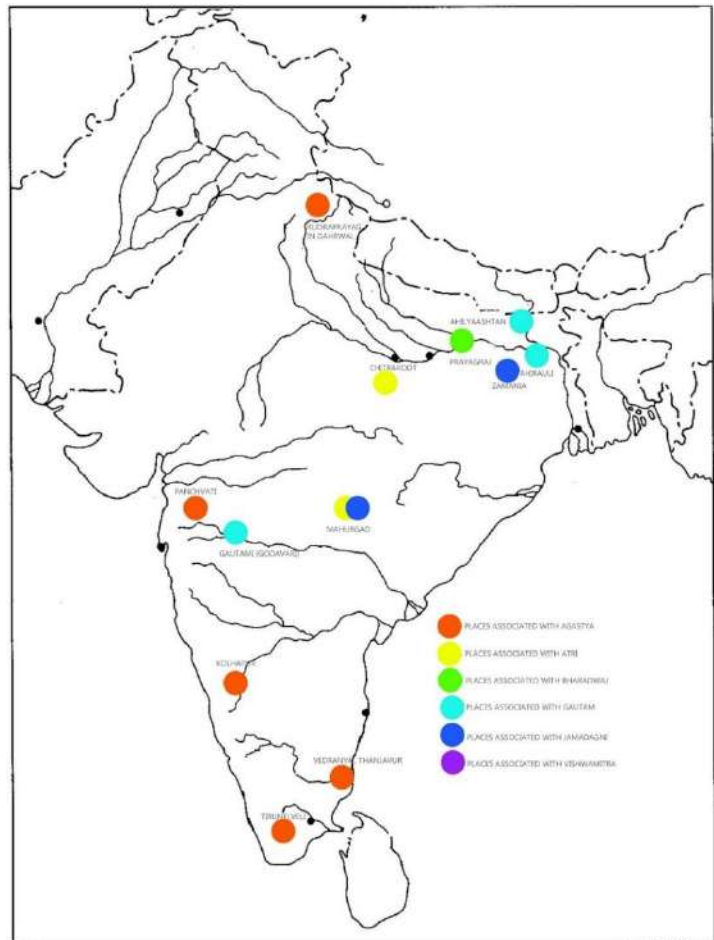
4. Conclusion:

The above cases give us an idea about the type of Physical manifestation mentioned in the *Mahatmya* of that region. The accuracy of the details is subjected to the myth itself. The myth tries to justify the origin of being by relating it to supernatural elements as seen in most cases.

It is seen that there are several types of manifestation that can be seen from each myth.

1. The first type is the direct manifestation of the Physical Landscape of the region. Hence the associated Physical Landscape also gets termed as a sacred site since it is obtained through divine intervention.
2. The second type of manifestation that can be seen is in the form of Representative structures. In this type, the Physical landscape itself doesn't play any role in the chain of events that happened in the Myth but a symbolic structure is built on its place to remember the event.
3. The third type is where both the Physical Landscape and the Representative structure can be seen where a symbolic structure is constructed to signify the origin of the Physical Landscape.

The common thread entwining all these places is a divine intervention that logically cannot be explained and hence termed as a Myth. The myth gets so tightly woven with the Physical manifestation that it becomes the identity of that area, town, and region. Such places acquire a sacred quality along the span.



Map 8: Map of India showing all the spaces associated with Saptarishis, Source: Author

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PLANNING AND MANAGEMENT OF TEMPORARY EMERGENCY HEALTHCARE CENTRES - A CASE STUDY OF PERIURBAN AREAS OF NASHIK.

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Abstract : The World Health Organization (WHO) defines primary healthcare as “a whole-of-society approach to health and well-being, centred on the needs and preferences of individuals, families, and communities.” “Primary healthcare, “the WHO explains, “ensures people receive comprehensive care. It is necessary to have an access to people for prompt health care in areas where economic, geographic, or cultural barriers limit access to affordable services especially during disasters. This paper attempts to address issues like accessibility, the immediacy of care, economical deploy ability and affordability, to health and well-being of individuals, and communities during disasters. The study will follow a qualitative research methodology where data will be collected from a comprehensive literature review. The comparison matrix shall be derived from the existing literature review and suitable case studies. The research will be a review of existing materials and systems of construction and study of new materials and technologies to arrive at a strategy to be used in selection of materials and systems for temporary shelters .A comprehensive strategy for selection and implementation of building materials and systems will optimize operatability and help support development of emergency shelters during mass casualties

Keywords: Temporary structures, primary health care centre, Prefabricated, portable construction, criteria for slection of temporary structures, medical facilities construction

1. Introduction :

Health care centres are central to provide emergency care and hence when a disaster strikes, the society falls back upon the health care centres to provide immediate aid in the form of emergency medical care.

At disaster sites, an immediate response is needed. Natural and manmade disasters are of immense concern throughout the globe. Primary health centres (PHCs) represent the first tier of the Indian health care system, providing a range of essential outpatient services to people living in the rural areas. Limited public health infrastructure and lack of medical and support resources contribute the vulnerability of existing facilities in developing country like ours with limited resources.

In India, a network of over 25,000 primary health centres (PHCs), the first and lowest health tier, provide essential preventive, promotive, and curative health services in the rural areas. But any serious case has to be referred to a bigger hospital in the nearing city.

However when a disaster strikes, or in any emergency situation the facilities provided by the PHC'S are insufficient to tackle the rise in number of patients. Also, the location and accessibility of PHC'S is far

off and patients have to travel long distances to avail services or in perurban areas too the hospitals could be inaccessible . There is not only an urgent need to increase the preparedness of healthcare centres in mass casualties, but also the local administration have to expand their focus on providing immediate facilities to step up the preparedness of such centres. Facilities should be developed in a central accessible city location to cater to the villages and periurban areas of the city.

Some calamities can cause major disruptions to emergency services owing to failure of roads, bridges etc. Response to such emergencies should therefore be quick, easily accessible, procurable, erectable and flexible.

Hence healthcare buildings demand flexibility and adaptability in use and which can be constructed rapidly to meet tight programmes.

Buildings have been built in one place and reassembled in another throughout history. The world's first prefabricated, pre-cast panelled apartment blocks were pioneered in Liverpool. The idea of modular buildings constructed from prefabricated materials and parts has been around for a few thousand years. Roman armies carried their forts in prefabricated sections for easy installation once they arrived at their destination, and since then modular construction has only grown. The tent structures were designed as “instant dwellings” where traditional construction techniques for shanty settlements and squat are too slow.

Erection of temporary structures has been an answer for rapid erection of facilities in times of distress. Such temporary shelters ensure the safety of affected communities and also help prevent secondary events such as the spread of diseases. This has to be done both swiftly and efficiently.

1.1 Aim: To understand challenges and opportunities of healthcare centres in India and to suggest a response plan and procedure for its up gradation in disasters.

1.2 Research Question: What should be the emergency response strategy for temporary healthcare preparedness in disasters at rural level ?

1.3 Hypothesis: An organised response strategy for construction of temporary structures to support healthcare systems in emergencies will provide effective and optimal support in disaster management.

1.4 Objectives:

- To examine emergency care systems in India and to explore its scope and limitations.
- To study and analyze capacity building and preparedness measures for healthcare .
- To understand , identify risks and mitigation methods, resource management and nature of extended facilities required for setting up of temporary medical facilities.
- to establish a flowchart for setting up, support and control of healthcare facility.
- To incorporate community participation in this process.

1.5 Scope and limitation:

This study aims to provide a response plan for up gradation of rural healthcare centres among the various levels and types of hospital care .It will further look into the management of temporary structural system to support such healthcare facilities to give prompt , fast track solution in disasters.

2. Research Methodology

- A qualitative study, using questionnaires and case studies was used to investigate approaches towards provision of shelters during disasters.
 - Data was collected through in-depth interviews of technical people involved in disaster management in Nashik area such as PWD and disaster management cell executives. The priorities are defined depending on the preferences of knowledgeable assessment of local experts like Architects, structural designers, contractors and government officials.
 - An intensive literature review was conducted including disaster management and emergency response policy and practice and theory applied as a response to emergency healthcare in disasters. Using the results of the literature review, the criteria's were summarized and weightage was given to the priority of criteria's depending on case studies of different materials used as well as interviews and questionnaire surveys.
 - Temporary shelter systems around the world and in India , in the past as well as future trends are studied.
 - A study of materials that are used or can be used was done by studying brochures as well as actual applications.
 - Also, an evaluation of merits and demerits of various materials and construction systems that can be used is done and evaluated with respect to the multiple criteria's to arrive at a strategy for selection of possible approach for such projects.
- A study of building construction approaches in disasters like earthquakes, floods and fire was done to understand the challenges and approach for selection of material and construction system in Nashik area.
- Evaluation of local criteria's such as proximity of material supply from site, Strata of ground, climatic factors is also done and priorities are established along with global factors.
 - Further specific approach in the selection of materials with respect to medical care and its criteria's are considered.
 - Data analysis was done by the AHP method by establishing priority amongst criteria's and assigning weightages. Hierarchy was then refined based on the assessment and feedback given by a group of 15 experts in the questionnaire survey. The experts were technical people like architects, structural designer's and contractors who have studied and worked in the temporary construction techniques and medical facility buildings.

3. Data Analysis:

Priorities of criteria for consideration of materials and systems of construction for medical facilities were established from the response of experts in the field. Specific preferences for use in Nashik region considering local factors was also analyzed from the survey.

Material preference with respect to the priorities was established from the material comparison matrix. Complete bucket list of data collection was differentiated into existing systems in use and Alternative systems catering to more parameters.

Table -1: Priority Analysis table for Materials

Analysis		
1	Puff Panels	Most Preferred
2	PVC Sheets	
3	Metal or Asbestos	More Preferred
4	Recycled Ply	
5	Aerocon	Less Preferred
6	Cloth	
7	MDF	Not Preferred
8	Bamboo Mat Board	
9	Mass Timber	
10	Precast	

Table -2: Priority Analysis table for Materials

Priority depending on Percentage			
Sr. No	Criteria	Total	%
1	Availability	61	5.54
2	Time required for erection is less	60	5.45
3	Fire safety	57	5.18
4	Economical	55	5.00
5	Can be erected with unskilled labour	53	4.81
6	Operational safety	53	4.81
7	Design and joining details	52	4.72
8	Strength and Tolerance	52	4.72
9	Waterproofing	50	4.54

10	Light weight	50	4.54
11	Modular construction possible	49	4.45
12	Standardization	48	4.36
13	Less maintenance and serviceability	48	4.36
14	Less labour intensive	47	4.27
15	Quality of material	46	4.18
16	Environmentally more suitable	42	3.81
17	Durability	42	3.81
18	Sustainability	41	3.72
19	Mechanized systems	41	3.72
20	Dimensional accuracy	41	3.72
21	In house production	40	3.63
22	Insulation properties	35	3.18
23	Life span	34	3.09
24	Transport	4	0.36
		1101	

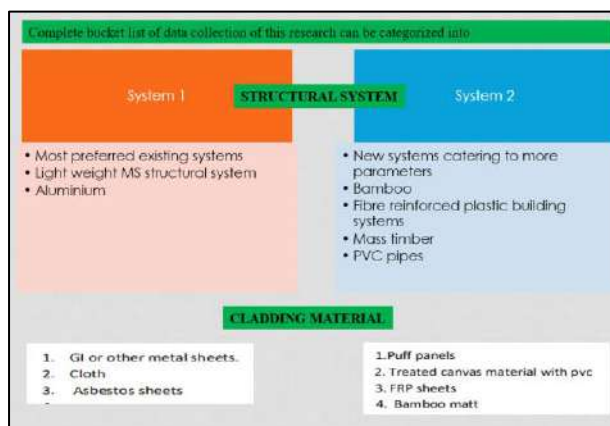


Fig: 1: Complete bucket list -1

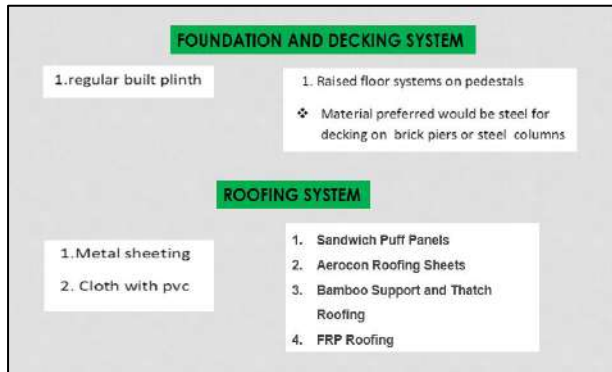


Fig- 2: Complete bucket list -2

4. Discussion

The emergency plan for smaller hospitals such as community health centre may actually only focus around providing either mobile emergency care on the site of incident or providing intermediate stabilization and forward referral of serious patients to the nearest networked hospital. Such small centres can provide immense help in case of mass casualty by providing definitive care to such victims who are not seriously injured.

4.1 Disaster Scenario in Nashik District:

Health care networking will be a necessary step in preparedness of such centres. Network essentially means a dynamic link between various health care facilities of a given geographical area for optimization of available resources.

The District of Nashik, is vulnerable to various kinds of hazards like flood, earthquake, fire hazard, drought, road & railway accidents, chemical hazard, communal violence, epidemic, hailstorm, heat wave & cold wave, stampede etc. The devastation caused by various kinds of natural and manmade hazards has posed a challenge before the Nashik district administration and other responsible bodies like NGO's to analyse each and every decision making process to gear up the rescue and restoration during such situations as well as building up the capacity to face calamities in future.

4.2 Response mechanism to disaster in India :

Disaster response mechanisms in India typically makes use of existing built facilities of bigger scale, like schools and mangal karyalaya for use as temporary shelters owing to the basic amenities of toilets, electricity and water etc already available. But this can be done only if such buildings have remained unaffected by the disasters themselves and are in close proximity to the area affected with respect to accessibility by the affected people as well as facility givers. Also the availability of such ready facilities in the vicinity may not be there.

4.3 Proposed alternative response:

Temporary facilities can be erected on open lands close to the primary health care centres of the area, or on land close to the disaster-prone region and easily accessible. Also being temporary and reusable nature, the same unit can be used in multiple closely spaced regions on various occasions. Vacant land can be used for other purposes when not in use for such centres.

In this sense, the selection and location of collective temporary shelters is a decisive factor in the response to disasters. While the response has to be timely, it should not be hasty. There are multiple issues that arise with hasty erection of temporary shelters such as incomplete beneficiary selection, poor site selection, contextually inappropriate choice of shelter designs, materials and construction

technology, inflated costs, lack of community consultation or participation leading to inappropriate shelter and dissatisfied families.

Rapid needs assessment should be undertaken before deciding on type of shelter solution to evaluate their usability and contextual relevance over other forms of shelter support.

The temporary shelters should be constructed with a plan which guides the dismantling of temporary shelters while promoting maximum salvage and reuse of the materials.

This study therefore evaluates for temporary facilities to add to primary healthcare centres, and the deficiency of systematic approaches that support decision-makers in the selection analysis of temporary constructions for healthcare facilities.

Adoption of pre-fabricated shelters requires careful and detailed needs assessment so as to consider issues like suitability of standardized design, climatic performance, durability of materials, ability of local community to repair and maintain, need of external aids such as cranes, disposal of degraded shelter material in environmentally safe manner.

With respect to healthcare facilities additional criteria's of selection will be included such as

- Toxicity
- fungal and bacterial attack and decay
- Antimicrobial
- Sterile
- VOC's from materials
- recycling or biobased
- reusing
- Flexibility to accommodate health infrastructure such as gas piping and air conditioning.
- Material selection should be prioritized on the above criteria's for optimum use for the purpose for which they are essentially selected.

5.Findings

The initial results of this study comprehend the definition of the primary evaluation elements used to compose the criteria. The choice and availability of construction materials is one of the key factors that determine the design of the temporary shelters.

As a response to increasing health facility in mass casualty, practical approach will be to erect temporary facilities whenever required and after the purpose is served, material should be dismantled, packed and transported to base where it can be maintained till further use.

Establishment of a local database or a protocol for erection of temporary structures for mass casualties will give a permanent guideline for approach at the time of casualty. At the strategic level, the model allows the collection of a diverse range of facilities to function as temporary structures and the prioritization of best alternatives in the case of a disaster.

Modular systems of construction using light weight structural systems and variety of roofing and cladding systems depending on priority of criteria's is best suited for temporary construction.

The best materials to be used for temporary construction from the point of view of reuse & recycling will be manmade materials that can be reused such as steel sections and galvanized iron or FRP sheets or other recycled materials boards. Natural materials like bamboo can be an alternative subject to availability

Light weight steel or aluminium is the most preferred material for use as structural system for temporary sheds in Nashik region. Bamboo or PVC pipes is the second best alternative

Use of prefabricated systems with predefined cladding roofing and flooring options will improve levels of quality, reduce material wastage and construction period.

Basic foundation system using ready steel members or brick piers and floating floor construction system with steel beams and flooring is recommended instead of conventional plinths

Identify and ensure resources of labour and transport along with the criterias discussed for speedy construction of systems.

Trainings could be given to dedicated staff by officials for erection of selected systems in an area.

6. Strategy.

- To identify and categorize hazards in the region where temporary shelters are proposed.
- risk assessment of the hazards
- Assess climatic condition and geography of the area
- Check on material and labour availability
- Evaluate the material on priority based on weightages.
- Evaluate application of structural system based on recommendations in the study and hazard category.
- Evaluate non-conventional materials available in the region and systems if any based on priority and material comparison matrix.
- Identify resources such as equipment, labour and transport for the materials selected.
- Identify location and resources for storage and maintenance of material when dismantled and stored for further use.

7. Conclusion

This study helps address one phase of the disaster management cycle. It attempts to organize the selection and construction of healthcare facility which is a preliminary step considering challenges facing the built environment from disaster perspective. It proposes a guideline and systematic approach to support the decision process of selecting temporary shelters. New materials and systems can be evaluated based on the multicriteria model and considered for use.

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Transformations in Architectural Character by Analysing under-Flyover Lost Spaces: A Future Flyover in Patna

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Abstract: Patna, in the alluvial plains of the East Indian state of Bihar, serves as the state capital. Patna's metro population in 2022 was 2,529,000, up 1.89 percent from the previous year. Uses for peri-urban areas have emerged in tandem with modern urbanisation, and they capture areas experiencing rapid transition from rural to urban. The paper aims to identify various lost spaces under flyover in different locations of Patna and to change the architectural character by giving design interventions for the spaces. The objectives of this paper include physical expansion of the flyover, knowing about migration of people from rural to urban under flyover spaces, establishment of new economic activities done by people under flyover spaces, development of city services if any, under the flyover spaces, the changed architectural character by analysing the under – Flyover spaces in Patna, and also designing under – flyover lost spaces for a future double-decker flyover in Patna.

Keywords: peri-urban areas, under- Flyover spaces, Architectural Character, Patna flyover.

1. Introduction :

The widespread construction of flyovers created a number of lost areas that could damage the sociological, cultural, urban fabric, and identity of the cities they crossed. An attempt to relate voids to the urban environment of India and taking into account the possibility for urban voids contribute to the creation of new urban void types and the public realm. For this, some of the holes have been categorised using information and expertise of Indian cities. Ownership, their contribution to the vibrancy of the street, and their potential for transformation were the determining factors in the selection of these vacancies.

Spaces under elevated flyovers in India are blighted by arid terrain and unused interstices, which have disconnected the urban fabric from rail lines and the flyovers themselves. It is expected that the majority of the places beneath new flyovers will be inaccessible, forgotten, and turn into a haven for illegal activities as they protrude from the dense urban structure. However if these spaces are being converted into playground areas, gardens, parks or buffer spaces can be used to create a lively street and also resting place for travellers/people where the modes of transport change.

In the process of turning areas beneath elevated highways into public spaces, the main aim is to set the objective of creating the ideal public space, where people congregate and go right away to get away from the bustle of the city (Biesecker), (Elshater), (Walljasper). If only one justification is used to imitate successful public spaces, the literature advises designing them so that people can engage and briefly escape the clamour of the city. The areas under the highway should be put into public use, which is they resist doing so. Additionally, regardless of the differences on a personal, social, or social level, persons of all backgrounds can access public space (Biesecker). Similar to this, open spaces should allow for variance and provide people from diverse backgrounds with the necessary flexibility and

consistency (Elshater), (Kurniawati). This paper aims to analyse the lost spaces for a street stretch by designing them, also taking the flyover as a case study of Patna.

2. Literature Review :

The Literature Study consists of three locations; first location is Mumbai, India, Nanalal D Mehta Garden, second location is AMC Flyover at IIM Junction and third location is Lima, Peru, Ghost Train Park.

2.1. Mumbai, India: Nanalal D Mehta Garden

Location is Matunga, underneath the Tulpule Flyover

Mumbai's first garden-under-flyover was made public by architect Pallavi Doke. After the devoted labour of several Matunga people, on June 13th, 2016. Features or induced behaviours: A 600-meter long walking/jogging path with vegetation on the sides that is shaped like the Narmada River. 300 lights and 11 rotatable CCTV cameras installed throughout the stretch, coupled with 24/7 security, to ensure safety. The underside of the flyover is lit up with appropriate LED lighting and ground illumination along the pathways (DUAC).

Residents of Matunga started the project by approaching the Mumbai Municipal Corporation (BMC) to create green areas in their neighbourhood. The idea was a success after it was put into action because the inhabitants of Matunga made sure the stretch was kept clean and secure around-the-clock. Residents were able to claim the area as their own through public engagement, fostering a sense of ownership. Additionally, because it was close to the residential neighbourhood, locals could easily access it (DUAC).



Figure 1: Pictures showing day and night views of Nanalal D Mehta Garden, Mumbai (DUAC).

2.2. AMC Flyover at IIM Junction, Ahmedabad 2012-2015

The Ahmedabad Municipal Corporation (AMC) proposed the flyover at the IIM junction in Ahmedabad to alleviate traffic congestion in the urban area. With two campuses of the Indian Institute of Management, Amrut Modi Management School, and the Blind People's Association Building at its four corners, the location is a significant hub for the city's educational system. In this difficult setting, HCP started its work by conducting traffic count surveys at the intersection, a study of citywide traffic patterns, and a feasibility assessment of the project (HCP).

A normal flyover project cannot compare to the AMC Flyover at IIM. Flyovers were designed with several features that would typically be disregarded, such as integrated lighting and rainfall pipes in the structure. The 1340 square metres of built-up space under the flyover was intended to be a multifunctional covered space. The project involved the reconstruction of a 920 m stretch of road, comprising 504 m of the Flyover and the entire right-of-way width, including the Flyover's four lanes. The development was done in a sequence that would have the least negative influence on the area

because the site was a major intersection. The AMC Flyover at IIM serves as an example of the value of architects in the elegant and thorough design of urban infrastructure projects (HCP).



Figure 2: Pictures showing AMC Flyover at IIM Junction, Ahmedabad, 2012-2015 (HCP).

2.3. Lima- Peru: Ghost Train Park

Due to its internal highway system, Surquillo, where the RUS. Lima project was situated, has a substantial industry and commercial base. However, it lacks parks and has some issues with hygiene and beautification. The abandoned Lima electric train station project has been transformed into the Ghost Train Amusement Park. The park has been constructed around abandoned concrete columns, decorated with vibrant colours, and strung with recycled materials to form rides and games. It is situated in the heart of Lima's bustling urban setting. The deteriorating area was transformed into a theme park with playgrounds and outdoor activities. Features or induced behaviours: A canopy line, swings, climbing walls, and car tyres give local and visiting kids hours of entertainment. By introducing activities that the area lacked, the underspace, users accepted and protected the development (neighbouring residents) (DUAC).



Figure 3: Pictures showing Lima -Peru, Ghost Train Park, decayed spaces converted into fun and entertainment zones for children (DUAC).

3. Design Principles Involved :

Some of the design principles involved while designing under elevated structures or under flyovers spaces. Some of them are discussed (DUAC).

3.1. Accessibility

3.2.1. Secure Connections :

Given that the majority of the places would be in the path of fast-moving vehicle traffic, it is essential to create secure pedestrian connections and crossings in compliance with the relevant statutory requirements.

3.2.2. Universal Accessibility :

The designed spaces must include universal accessibility features in accordance with the relevant statutory requirements.

4.1. Scheduled Activities

4.2.1. Recreational :

(a) For Playing Areas : Tot lots, sports hub -The developed places must have the proper attractions to activate them while taking into account the neighbourhood type, social character, safety and security, and accessibility alternatives. (b) Recreational trails for pedestrians and cyclists -The developed places must have the proper attractions to activate them while taking into account the neighbourhood type, social character, safety and security, and accessibility alternatives.

4.2.2. Landscaping for Planting Trees :

Use native, drought-tolerant, hardy species. On the below, grass are not permitted because they require a lot of upkeep and sunshine.

4.2.3. Societal and Cultural :

(a) Spaces that can be used for civic dialogue and social engagements -Public gathering areas with planned activities that promote safety and provide sitting alternatives. (b) Public Art -Relevant and participatory public art (when available) should be strategically placed with motorist safety in mind.

4.2.4. Utilities :

(a) Lighting Purposes : Relevant and participatory public art (when available) should be strategically placed with motorist safety in mind. (b) Signages : Appropriate signage must be provided to ensure safe passage through the planned areas and to express safety precautions such as access, crossings, etc. (c) Advertisements : Location and size must adhere to the relevant regulatory regulations. (d) Rain water harvesting : To achieve the maximum collection and storage of surface run-off from flyovers, highways, etc., appropriate sites must be set aside for rain water harvesting (RWH).

4.2.5. Smart Attributes :

(a) Facilitation of Wi-Fi & Smart Poles : Smart utilities that are strategically placed will draw customers, benefit them, and allow for technological integration. (b) Contributors : Local Government - The relevant Local Government shall oversee implementation and maintenance, Some Private Organisations - Private organisations may adopt areas and preserve them as stretches of public land as part of a CSR (Corporate Social Responsibility) campaign, prompted by a variety of activities, Local Public -To enable a participative approach, the neighbourhood must be consulted to understand the demands of the users.

4.2.6. Preservation :

Roles and Obligations : The relevant Local authority shall be in charge of the care and preservation of the spaces.

4. Recommended Use of Spaces :

(a) Entertainment Areas : Equipment-filled children's play area , Open gyms for a variety of age groups, pathways for running/cycling and play areas etc.(b) Cultural and Social Tasks : Outdoor theatre, public displays, Spaces for gatherings and activities, weekend farmers markets and vending areas evening shelters.(c) Services and Auxiliary Infrastructure : Parking, City information centres, food trucks, police stations, and taxi stands, Public facilities other public amenities, such as phone booths and ATMs.d) Smart Attributes : Rainwater collection, Internet hot-spots, Ads on the internet and a map of the city. (DUAC).

5. A Case of Patna:

Although the city's new flyovers have helped with traffic flow to some extent, encroachers frequently erect stalls there. Encroachers have essentially transformed the open spaces under flyovers into business locations, selling everything from tea, chicken, mutton, and fish to hair clipping. Furthermore, trash from surrounding construction sites is dumped in these locations. In addition to hurting the city's aesthetic appeal, encroachers are obstructing traffic flow. Use of areas currently covered by elevated development.

5.1. Some Flyovers in Patna:






FLYOVER	YEAR OF COMPLETION	CURRENT SITUATION	USES
1. Digha AIIMS Flyover	December 2018		It is a rail-cum-road bridge at the junction of Ganga Path. Under-Flyover Spaces are mostly covered with river and in some areas wild vegetation.
2. Mithapur Flyover	June 2017		Under-Flyover Spaces are mostly roads for traffic movement as well as there is a big landscaped park for commuters which is also a roundabout.
3. Chitkohra Flyover	November 2019		Under-Flyover Spaces are mostly covered by street hawkers and slum squatters.
4. Sachivalaya Halt Flyover	2012		Under Flyover Spaces are mostly roads and in some places landscaped park in the form of a traffic intersection. Here it is a triangular shaped landscaped Park as a rotary for easy traffic movement on roads.
5. Rajendra Nagar Flyover	2012		The flyover lies in the area of lush greenery and busy streets. The under flyover spaces are at places used by street vendors.

Figure 4: Pictures showing some Flyovers in Patna

5.2. Site Introduction:

The site chosen is situated in the bakarganj area around Patna University Campus, Patna. The coordinates of site are 25.6169° N, 85.1714° E. The street stretch is on Ashok Rajpath (NH 922) street from NIT More till Kargil Chowk. The site has an incredible possibility of proposing meaningful under-flyover spaces because it has proposed two lane double decker flyover and two proposed metro stations are present on the site.



Figure 5 : Google Maps showing Ashok Rajpath and vicinity areas of Patna

5.3. Two Lane Double Decker Flyover on Site :

Double decker flyover on site is under construction stage. The name of project is Construction of Elevated Corridor from Kargil Chowk, Gandhi Maidan to Science College via PMCH, Ashok Raj Path, Patna, Bihar (2-Lane Double Decker). The District/Head-Patna. Description of Project is (i) Type of Structure-RCC/PSC / Steel Composite, (ii) Length of elevated corridor-2.2 km, Length of Tier-1 is 1.5 km and Tier-2 is 2.2 km, (iii) Carriage way-2 x 2-lane Double Decker (Tier-1 two lane + Tier-2 two lane), Date of Start is 15.01.2022, Schedule Date of Completion is 14.01.2025, Contractor is Gawar Construction Limited, DSS- 378, Sector- 16-17, Hisar 125 005 (Haryana). Physical Progress is Foundation (20%), Sub-Structure (15%), Super-Structure (15%), Expenditure (Rs. In Crores – 5.40).



Figure 6 : Pictures showing underconstruction stage of Two Lane Double – decker Flyover on Site



Figure 7: Plan showing the layout of Two Lane Double-decker Flyover on Site.

5.4. Design for under-flyover, lost spaces under Two Lane Double-Decker flyover:

Space between Column No. 8 (Starting BN +2 School) till Column No.24 (Till PMCH Residential Quarters), at a height of 9 metres and column to column spacing is 30 metres, has been designed in plan to give meaningful spaces,entertainment as well as parking spaces which are lost spaces below the under-constructed double decker flyover on Ashok Rajpath,Patna.

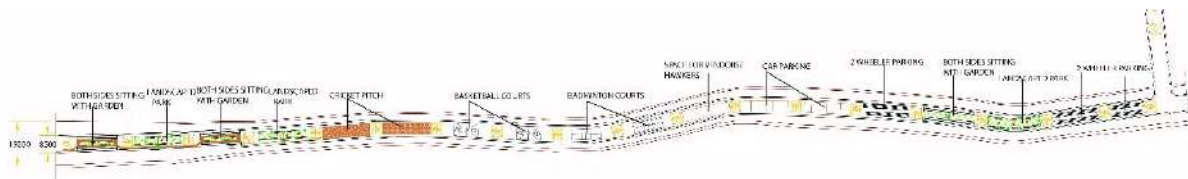


Figure 7: Plan showing the design of under-flyover spaces from Column No.8 till Column No.24 on Site(Author).

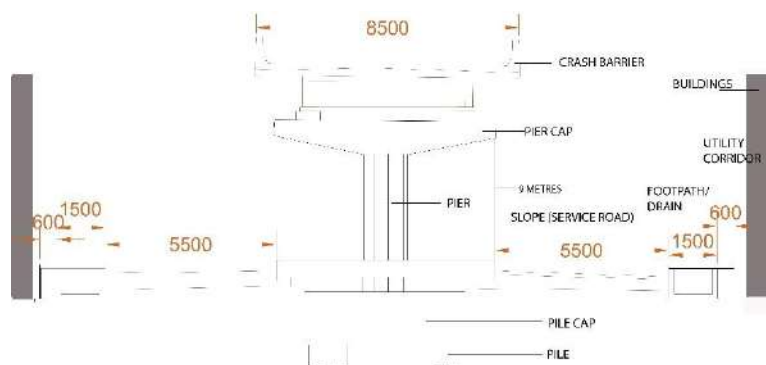


Figure 8: Section with road cross- section and Column , for two-lane double decker flyover on Site(Author).

6. Conclusions :

Flyovers not only help in the decongestion of the traffic but also give pedestrians a meaningful street by utilising the under – flyover spaces into beautiful gardens with sit-outs as well as playing areas for kids. Also, in some cases these spaces used as a resting place for commuters and they can park their own private two- wheelers and four- wheelers in dedicated parking spaces, areas for street vendors,

hawkers' spaces thus need to be designed. The squatters should be treated well and some spaces should be designed to keep them in consideration.

7. Acknowledgements :

I'm appreciative to Bihar Rajya Pul Nirman Nigam Ltd. (BRPNNL), which gave me the useful information I needed for this research paper.

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Assessment of sports infrastructure in peri-urban areas of Baramati

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Abstract:

Despite being one of the most populous country, India produces few athletes capable of competing at the international level. In spite of schemes like "Khelo India," the majority of young people do not take sporting careers seriously, even in urban areas. One can imagine the plight of rural youth deprived of some basic sports infrastructure. In such a scenario, it is important to record and document available sports infrastructure, especially in peri-urban areas, so that demand for improvement of current and planning of new facilities can be raised. This research aims to study and inspect the sports infrastructure and facilities in schools in the peri-urban areas of Baramati, the headquarters of Baramati Taluka in Pune district of the south-eastern Indian state of Maharashtra. For this study, nine schools were selected from different villages. The schools were physically visited for data collection as required. Primary data was collected by interviewing sports teachers in various schools in villages around Baramati and also through the researchers' own mapping, observations, and field notes. The data about sports ground measurements, infrastructure, qualifications of sport teachers and achievements were separately compared with standards to find the percentage of performance. The results were analysed to draw conclusions and calculated in percentage form. The findings revealed that poor infrastructure and coaching can have an impact on students' athletic achievements. Many schools in peri-urban areas have sports fields according to standards, but the maintenance is poor. The athletes do not get enough opportunities to compete, and schools place more stress on academics than sports achievements. The study conclusively proves that the sports achievements of peri-urban sportsmen depend more on the coaching they get and their own perseverance than on sports infrastructure.

Keywords: Periurban, schools, sports infrastructure, assessment

1. Introduction:

Country's health is the greatest asset. No country can go far in development without proper health of population. Physical activity is one of the main sources of good health, both mentally and physically. Swami Vivekananda said, 'You will be nearer to heaven playing football than studying the Bhagavad-Gita which means that a person who is physically and mentally strong can understand and gain knowledge more efficiently compared to an unhealthy person. Here he states the importance of physical health, which will definitely come from physical activities and will be responsible for the massive growth of the nation.

Many villages do not have good infrastructure for the sports they play, which directly affects interest of the youth. Some schools have unmarked and non-standard playgrounds when compared with their rules and regulations. Schools in rural areas have few sports to play, but they too are not at their best. There are some parameters to inspect the condition of sports infrastructure, such as comparing the ground dimensions with the standards of the game and inspecting the ground maintenance, such as the surface condition and drainage provisions, etc. Sports infrastructure defects can occur due to different reasons, such as construction faults or poor attention to the maintenance of the equipment. Achievement history of the participants in sports at different competition levels can also state the condition of the sports facilities at that school.

2. Background of the study:

Proper sports infrastructure is an integral part of the country's development. India has one of the world's largest populations, the largest democracy, and incredible talents dating back to ancient times. India also invented games like chess, but India is also far away from the countries that achieve huge success in sports. There might be different reasons for the poor progress of India, but one of them would be poor infrastructure for its population in rural areas. According to a report, the majority of Indians who participate in sports at the national and international levels come from rural areas, as seen in the 2010 Commonwealth Games, because these are the people who are aware of the process of participating in sports. But there are many hidden gems in Indian rural areas that remain hidden due to a lack of sports infrastructure and coaching.

3. Context of the study:

For research study, Baramati Taluka from Pune District, was selected. Reason behind selecting this city was Baramati is a rapidly developing city in Pune district in terms of sports infrastructure and is also predicted to be an iconic sports centre. Every year, different sports matches are held in the city. Matches of the Maharashtra State Olympic Kabaddi League were recently played in Baramati in January 2023. More such matches related to badminton, volleyball, etc. are played here. So, using Baramati as the urban region, this study will examine the sports infrastructure of villages surrounding Baramati or those that fall under the Baramati Taluka. The data required will be collected by physically visiting the site, through mapping, observations, field notes, and interviewing questions with school sports teachers and coaches.

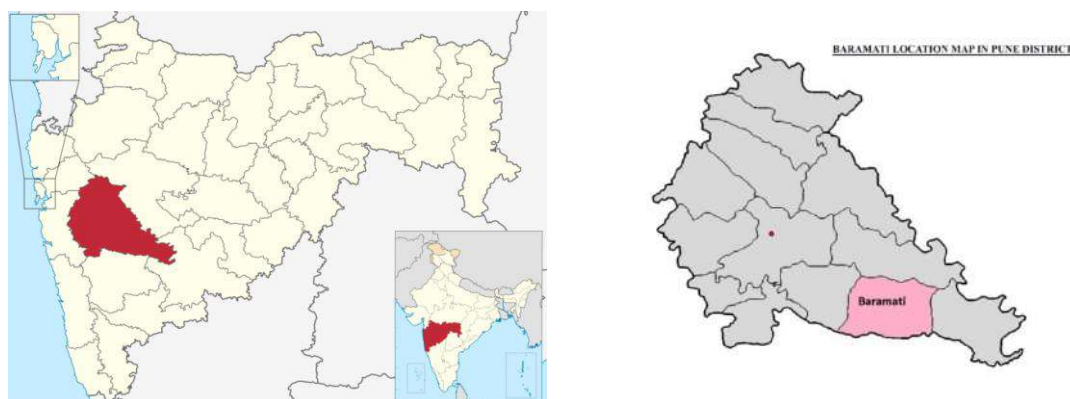


Figure 1: Map showing Baramati Taluka location

4. Literature Review:

Dr. P. P. S. Paul Kumar conducted a survey of physical education facilities in government schools in the Srikakulam District of Andhra Pradesh. Purpose was to inspect the sports infrastructure of schools. Twenty schools were chosen, ten were government-run. Method adopted for survey was a questionnaire. Study was restricted to the Srikakulam District area. Most common games played in the schools were selected for the comparison. The data collected was analyzed, and Author came to the conclusion that the schools had failed to provide a well-balanced physical educational programme and facilities. Similarly, another study was done by Kumaraswamy K and Appanna M Gasti, which was based on an analysis of physical education and sports facilities in training colleges in Karnataka State. Purpose of was to find about the physical education and sports facilities in training colleges. Study was limited to four academic divisions from the state of Karnataka. Overall, forty colleges were selected within the divisions. To analyse the collected data, a simple percentage method was used with the Statistical Package for Social Sciences, 23rd edition.

In addition to the two studies mentioned above, Asst. Professor Dr. Suresh Patil of the College of Horticulture in Koppal District and Vithal D. Metri, Physical Education in Bagalkot, conducted another study. Purpose of study was

to find out about the sports facilities government high schools within Koppal Taluk. Author physically visited the schools and collected the data using questionnaires created for the school management. For this study, twelve schools were selected. Data analyzed stated that many schools do not have the minimum requirement of sports facilities. Fourth research study, conducted by Nitesh Kharkhur, PhD research scholar, and Dr. Sandeep Kumar, Professor and Head, Department of Physical Education, Meerut University, examines the relationship between sports achievement and sports personnel in government and private schools. Fifty schools were randomly selected from the NCR capital, of which twenty five were government schools and twenty five were private schools. Data was collected using Google form, which contain all the required information. The correlation between sports achievement and the infrastructure of both government and private schools was positive and showed that sports infrastructure had an impact on the students' sports achievement.

The literature review helped to finalize the research and analytical methods. The parameters of evaluation could also be decided based on the learning of literature review.

5. Research question:

What is the condition of sports infrastructure of Schools in Villages around Baramati Taluka?

6. Aim:

The aim of this research is to study and inspect the sports infrastructure using different parameters, comparing sport ground measurements with the national standards of the game, achievements of the schools in competitions, qualifications of the sport teachers in schools.

7. Objectives

- 7.1 To document and record the existing sports infrastructure in 9 villages around Baramati
- 7.2 To understand and define the parameters for assessment of sports infrastructure.
- 7.3 To analyse and compare the existing conditions with standards.
- 7.4 To comment upon the existing conditions and recommend to relevant authorities' remedial course of action.

8. Scope:

- 8.1 Assessment/evaluation of 9 different schools.
- 8.2 Education level of selected schools
- 8.3 Measurement of school playground area.
- 8.4 Collecting the following data
 - 8.4.1 Strength of students studying in the school
 - 8.4.2 No. of sports teachers and their gender
 - 8.4.3 Financial aid of the school
 - 8.4.4 Inspection of sports infrastructure based on different parameters

9. Limitations:

- 9.1 For this research, all villages of Baramati Taluka are not studied.
- 9.2 The research was done on some parameters that were assumed to be affecting directly or indirectly.

10. Research Methodology:

- 10.1 Different schools were selected on the basis of their interest in participating the survey from the Baramati city.
- 10.2 Mapping of the schools, Observation and field notes.

- 10.3 Onsite measuring of the sports play area and comparing with the national standards of those particular sports.
- 10.4 Inspecting sports infrastructure using parameters like Sports ground surface material used, Services of playground such as Surface/Strom water drainage system and facilities like provision of Electric/Solar lights near playgrounds etc.
- 10.5 Using questionnaire method for the purpose of collecting data like Strength of the school, Education level, financial aid, No. of Sports teachers and their gender with qualifications and sport achievements.

11. Hypothesis:

It hypothesized that the sports infrastructure and other related facilities provided in the village schools on the periphery of the Baramati Urban Area are poor. This directly affects the growth and development of students' sports achievements.

12. Discussion and analysis.

The research was conducted during August and September 2022. It was decided that 9 schools should be studied. The schools were selected on the basis of their willingness to participate in the study from 20 schools that were approached. The schools selected for the study are situated at various distances from Baramati city ranging from 5 km to 25 km. The following map (Fig-2) shows the distance of villages from the core of Baramati city.

Table 1: List of Schools included in the study.

School- A	Jijabai Dadasaheb Gawade Vidyalay and Junior College, Parawdi	School- F	Chatrapati High School, Soangaon
School- B	Shri Wagheshwari Vidyalay School, Nirawaghaj	School- G	Nav Maharashtra Vidyalaya, Pandare
School- C	New English Medium School, Mekhali	School- H	Shivnagar Vidya Parasak Mandal's English Medium School, Malegaon
School- D	Shri Chatrapati High School, Katewadi	School- I	Swatantra Vidya Mandir, Vadgaon Nimbalkar
School- E	Shrimant Hausabai Pandurang High School, Pimpali		

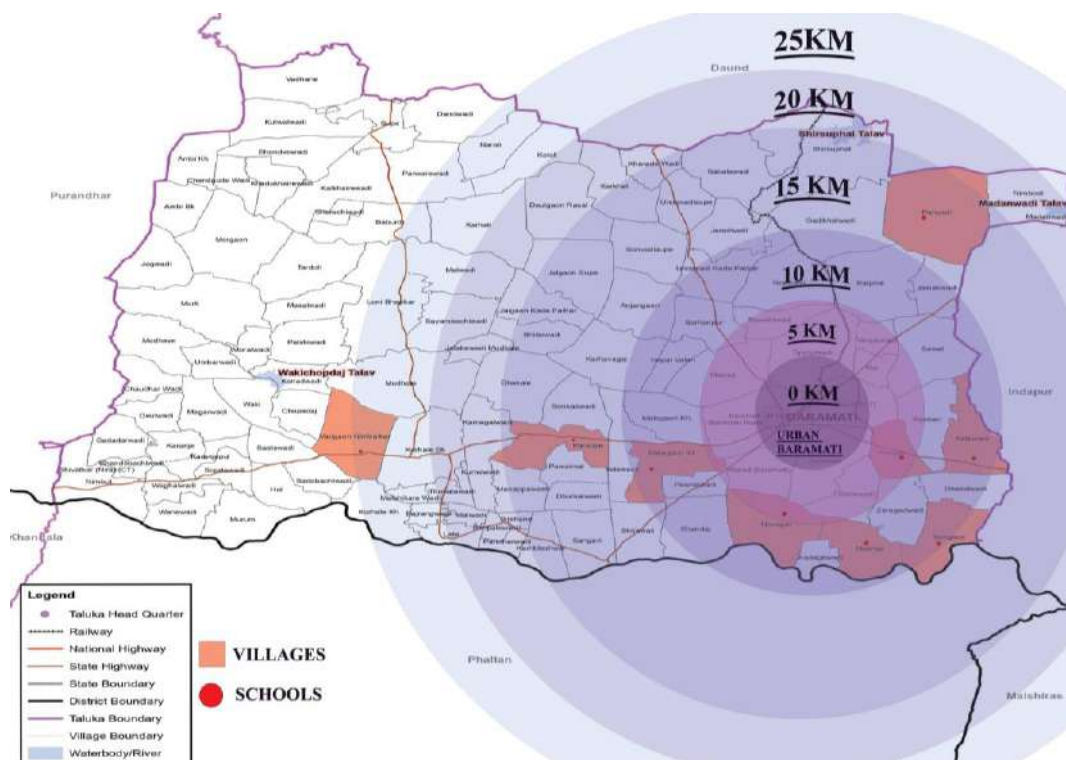


Image credit: Maharashtra Remote sensing application centre

Figure 2: Map of Baramati and distance of its Peri-urban villages

Questionnaire was generated with the help of literature review and discussions with the co-author and references. This was distributed within the schools and consisted of questions about the data required. Below is some data analysis:

Table 2: Basic information about the schools (Questionnaire Survey)

	Range	No. of Schools	No. of	Range	No. of Schools
Strength	400-500	02	Sports Teacher	One	08
	501-600	02		Two	0
	601-700	03		Three	01
	701-800	02	Gender of Teacher	Male	08
Educational Level	Up to Primary	00		Female	0
	Up to Secondary	09		Both	01
Playground Area	Less than Acre	04			
	Between 1-4 Acres	05			
	More than 4 acres	0			
Financial Aid	Private Organisation Aided	0			
	Government Aided	0			
	Both	09			

After basic understanding about the schools and the sports infrastructure the author personally visited every school, documented and verified the physical infrastructure of sports in each school. This was compared with the standards (Ref. table no.8), analysed with weighted percentage and marked the scores against each school. Further the quality of infrastructure was evaluated by the researchers own observations and field notes. In this evaluation the surface material of the ground (applied and original), the surface drainage provision, obstacles if any and provision of evening

illumination were considered for three sports that were regularly played in the schools viz: kabadi, kho-kho and volleyball. These are presented in table no. 3,4,5. The data about achievements of every school in sports in past 10 years was collected through questionnaire survey filled by authorities of every school. This data was tabulated to compare with the quality of sports infrastructure to find clear co-relation between infrastructure and achievements. Data was collected on the qualifications of the sport teachers and was analysed in percentage. (Ref. Table no.8)

Figure 5: Percentage of Standard game measurements



Figure 6: Percentage of Quality Sports Infrastructure

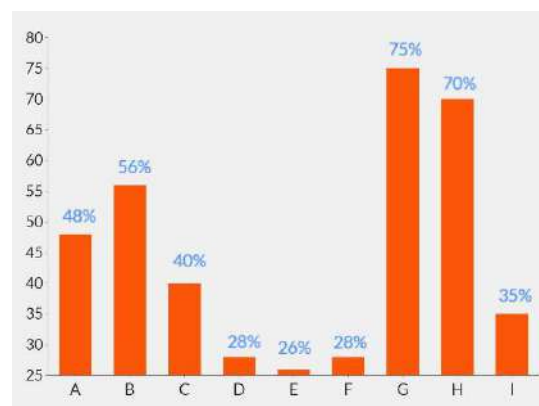


Table 3: Comparison of Kabaddi sport infrastructure with its parameters

Sports	Parameters	Recommended	Description								
			A	B	C	D	E	F	G	H	I
K A B A D D I	Ground surface quality check	Applying synthetic artificial mats OR Soft soil properly levelled	Present Brown soft soil	Present Red sandy soil	Present Red sandy soil	Present Brown soil	Absent Hard Soil Surface	Present Brown soil	Present Red sandy soil	Present Brown soil	Present Brown soil
	Provision to drain rainwater	For rainy season, a layer of brick peices and coal should be made below the top ground surface to absorb the water	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	Provisions of Electric/ Solar lights for evening games	Ensure good visibility and avoiding the glare of light on players	Absent	Absent	Present Electric pole lights	Absent	Absent	Absent	Present Electric lights	Present Electric lights	Absent
	Physical obstacles in the sports ground.	The ground should be free from any obstacles like boulders, lamp-post, drain line etc.	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Table 4: Comparison of Kho-kho sport infrastructure with its parameters

Sports	Parameters	Recommended	Description								
			A	B	C	D	E	F	G	H	I
K H O - K H O	Ground surface quality check	Soft soil surface	Present	Present	Present	Present	Absent	Present	Present	Present	Present
			Brown soft soil	Red sandy soil	Red sandy soil	Brown soil	Hard Soil Surface	Brown soil	Red sandy soil	Brown soil	Brown soil
	Provision to drain rainwater	Slightly oval shape at centre to avoid water staging	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	Provisions of Electric/ Solar lights for evening games	Sufficient lights using Halogen at 4 corners, lamps at least 30 ft. Height from ground	Absent	Absent	Present	Absent	Absent	Absent	Present	Present	Absent
	Physical obstacles in the sports ground.	The ground should be free from any obstructions	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Table 5: Comparison of Volleyball game sports infrastructure with its parameter

Sport	Parameters	Recommended	Description								
			A	B	C	D	E	F	G	H	I
V O L L E Y B A L L	Ground surface quality check	Soft soil surface OR Synthetic surface	Present	Present	Present	Present	Absent	Present	Present	Present	Present
			Brown soft soil	Red sandy soil	Red sandy soil	Brown soil	Hard Soil Surface	Brown soil	Red sandy soil	Brown soil	Brown soil
	Provision to drain rainwater	There are no such recommendations, but one can use methods such as providing a 0.5% slight slope to the ground and a drain tile system.	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	Provisions of Electric/ Solar lights for evening games	Flood lights upto 400 watts can be used for clear visibility as required	Absent	Absent	Present	Absent	Absent	Absent	Present	Present	Absent
	Physical obstacles in the sports ground.	The ground should be free from any obstructions	Present	Absent	Absent	Absent	Absent	Absent	Present	Absent	Absent

13. Conclusion:

On the basis of the findings and inspecting ground measurements, the schools should be made aware of the standards. Many schools do not apply the recommended sports facilities, which reduces the quality of sport. We received more data from the school authorities using a questionnaire, which stated the number of students in each school, the school's education level, financial aid, the number of sports teachers, and their qualifications. We also collected information about the school's achievements in sports over the past eight years, which help prove the relation between achievements and other overall factors.

During comparison, it was discovered schools that met all of the standards made more progress in their achievements than schools with inadequate facilities. It is observed in the gender of the sports teachers there are more male teachers in schools than female teachers. Main issues raised during interviews with school officials were financial aid and a higher priority placed on academic studies over sports.

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Table 8. Common table with all the objectives

Types of Sports	Standard parameters	Standard Dimensions	SCHOOLS																	
			<u>A</u>		<u>B</u>		<u>C</u>		<u>D</u>		<u>E</u>		<u>F</u>		<u>G</u>		<u>H</u>		<u>I</u>	
			POINTS		POINTS		POINTS		POINTS		POINTS		POINTS		POINTS		POINTS		POINTS	
K H O - K H O	Total Area	30 X 19 M	30 X 19 M	10	30 X 19 M	10	30 X 19 M	10	30 X 19 M	10	30 X 19 M	10	30 X 19 M	10	30X10 M	10	30X10 M	10	30 X 19 M	10
	Playing Area	27 X 16 M	28.0 X 16.0	09	22.0 X 16.0	08	28.0 X 16.0	09	22.0 X 16.0	08	28.0 X 16.0	7.5	28.0 X 16.0	09	28.0 X 16.0	10	28.0 X 16.0	10	28.0 X 16.0	09
	Pole Distance	24 M central lane joining two poles.	20 M	08	20 M	08	20 M	08	20 M	08	20 M	08	20 M	08	20 M	10	20 M	10	20 M	08
	Cross lanes	8 nos. Cross Lanes	8 no.	10	8 no.	10	8 no.	08	8 no.	10	8 no.	10	8 no.	09	8 no.	10	8 no.	10	8 no.	10
	Pole Size	Height: 120-125 cm Diameter: 9-10 cm	120 cm 10 cm	10	140 cm 10 cm	09	No Poles	0	120 cm 10 cm	10	No poles	0	No poles	0	120 cm 10 cm	10	120 cm 10 cm	10	120 cm 12 cm	10
	Sub-Total Points			47/50		45/50		35/50		46/50		35.5/50		36/50		50/50		50/50		47/50
K A B A D D I	Length and Width	11 X 08 M	13x 10 M	08	11 X 08 M	10	14X12 M	08	11 X 08 M	10	11X08 M	10	11 X 08 M	10	11 X 08 M	10	11 X 08 M	10	13x 10 M	08
	Midline to Baulk Line	3 M	3.75 M	08	3 M	10	ABSENT	0	3 M	10	ABSENT	0	3 M	10	3 M	10	3 M	10	3.75 M	08
	Baulk Line to Bonus line	1 M	1 M	10	1 M	10	ABSENT	0	1 M	10	ABSENT	0	1 M	10	1 M	10	1 M	10	1 M	10
	Lobby	1 M	1.75M	08	1 M	10	ABSENT	0	1 M	10	ABSENT	0	1 M	10	1 M	10	1 M	10	1.75M	08
	Sitting Block	6 X 1 M	ABSENT	0	ABSENT	0	ABSENT	0	ABSENT	0	ABSENT	0	ABSENT	0	6 X 1 M	10	6 X 1 M	10	ABSENT	0
	Sub-Total Points			34/50		40/50		08/50		40/50		10/50		40/50		50/50		50/50		34/50
V O L L E Y B A L L	Ground Area	161 Sq.m	161 Sq.m	10	161 Sq.m	10	161 Sq.m	10	161 Sq.m	10	161 Sq.m	10	161 Sq.m	10	161 Sq.m	10	161 Sq.m	10	161 Sq.m	10
	Length X Width	18.0 X 9.0 M	18.0 X 9.0	10	18.0 X 9.0	10	18.0 X 9.0	10	18.0 X 9.0 M	10	18.0 X 9.0	10	18.0 X 9.0	10	18.0 X 9.0 M	10	18.0 X 9.0 M	10	18.0 X 9.0 M	10
	Attack Line	3 M from Net	ABSENT	0	3 M from Net	10	ABSENT	0	ABSENT	0	ABSENT	0	ABSENT	0	3 M from Net	10	3 M from Net	10	ABSENT	0
	Free Zone (Back)	3 - 6.5 M	ABSENT	0	3 - 6.5 M	10	ABSENT	0	ABSENT	0	ABSENT	0	ABSENT	0	3 - 6.5 M	10	3 - 6.5 M	10	ABSENT	0
	Free Zone (side)	3 – 5 M	ABSENT	0	3 – 5 M	10	ABSENT	0	ABSENT	0	ABSENT	0	ABSENT	0	3 – 5 M	10	3 – 5 M	10	ABSENT	0
	Sub-Total Points			20/50		50/50		20/50		10/50		20/50		20/50		50/50		50/50		20/50

	Total Points		67.3%	101/150	90%	135/150	42%	63/150	64%	96/150	43%	65.5/150	64%	96/150	100%	150/150	100%	150/150	67.3%	101/150
Parameters for inspecting the Sports infrastructure																				
Ground surface quality check	Good	09	Good	10	Good	10	Satisfactory	06	Poor	05	Very Poor	01	Good	09	Satisfactory	06	Good	08		
Provision to drain rainwater	Very Poor	0	Very Poor	0	Very Poor	0	Very Poor	0	Very Poor	0	Very Poor	0	Very Poor	0	Very Poor	0	Very Poor	0		
Provisions of Electric/ Solar lights for evening games	Very Poor	0	Very Poor	0	Good	08	Very Poor	0	Very Poor	0	Very Poor	0	Good	09	Good	09	Very Poor	0		
Physical obstacles in the sports ground.	Good	08	Good	09	Satisfactory	06	Satisfactory	07	Satisfactory	07	Good	09	Good	10	Good	09	Poor	03		
Store room space to store equipment.	Good	08	Good	08	Very Poor	0	Very poor	0	Very Poor	0	Very Poor	0	Good	09	Good	09	Satisfactory	06		
Changing room for players	Poor	04	Satisfactory	07	Very Poor	0	Poor	04	Poor	04	Satisfactory	07	Good	08	Good	09	Poor	04		
Total	48%	29/60	56%	34/60	40%	24/60	28%	17/60	26%	16/60	28%	17/60	75%	45/60	70%	42/60	35%	21/60		
Qualifications of Sports Teacher	B.P.Ed		B.P.Ed		B.P.Ed		B.P.Ed		B.P.Ed		B.P.Ed		M.P.Ed		M.P.Ed		M.P.Ed			
Total Achievements in Sports in last 10 years T – TALUKA LEVEL , D – DISTRICT LEVEL , S – STATE LEVEL , N – NATIONAL LEVEL																				
Kho-Kho	1-D, 1-T	02	1-T,1-D	01	1-T	01	2-T	04	1-T	01	1-T	01	2-T,1-D	03	3-T	03	2-T	02		
Kabadi	1-D,2-T	03	1-T	01	2-T	04	2-T	04	1-T	0	1-T	01	2-T	02	1-T,1-D	02	2-T,1-D	03		
Volleyball	0	0	0	0	0		1-T	01	0	0	0	0	1-T	01	2-T,1-D	03	1-T,1-D	02		
Total Achievements		05		02		05		09		01		02		06		08		07		

Note: In the above table, remarks represent scores such as, For Good: 08-10; Satisfactory: 6-7; Poor: 1-5; Very Poor: 0.

Roots to Save Lives: Rerouting City Routes

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Abstract:

Studies show that the time delays in transporting patients and accident victims to the hospitals prove to be critical to ambulance travel. Most cities around the world have a mix of varied vehicle types commuting on narrow organic lanes as well as wide planned roads simultaneously which often leads to chaotic traffic conditions. Such situations and the lack of public awareness make ambulance commute very difficult in critical circumstances leading to loss of lives. Dedicated emergency lanes can be designated for new planned roads. It is not viable for cities which have evolved around an old existing core with network of narrow lanes and alleys. The paper investigates ways to reduce burden on major spine roads within a city by routing alternative routes for ambulance travel in order to save lives in addition to better public awareness and participation. The paper discusses case studies of old core areas of Pune city and its traffic patterns to reroute the city traffic as a means to save lives.

Key words: City roads, routing, ambulance travel

Introduction:

City roads and traffic flow patterns are always upgraded to keep up with the growing traffic demands over the years. Medical research all over the globe and development of technology has helped save many lives. All the advancement of medical research and technology will prove helpful only if the patient receives it in time. Time is the essence to save lives and curbing travel time of ambulance would prove critical in all emergencies. Ambulance travel time is very crucial at any given time. Intense studies and mathematical calculations are done to arrive at algorithms to be able to identify the shortest route for ambulance travel. The shortest route may not prove to be the optimal route for ambulance travel due to various reasons and hinderance causing blockage and traffic jams.

Nowadays it has become easy to predict intercity travel with the onset of several applications based on internet support and which are easily accessible on mobile phones and automobiles. The applications show the traffic scenario on a particular road and can predict the time taken to reach a destination. Though this prediction is useful for intercity commutes and local travel taxi services it does not actually help ambulance travel. Most cities' traffic thrives on an intricate network of roads and by lanes. This network helps the city traffic flow smoothly most of the times but it also has nodes and key points which slows down the traffic flow and also creates traffic jams. Traffic jams are significant hindrances for ambulance travel and is precisely a life and death aspect for the patient travelling in the ambulance. The paper tries to review the existing ambulance travel and the existing road network of different areas in Pune city.

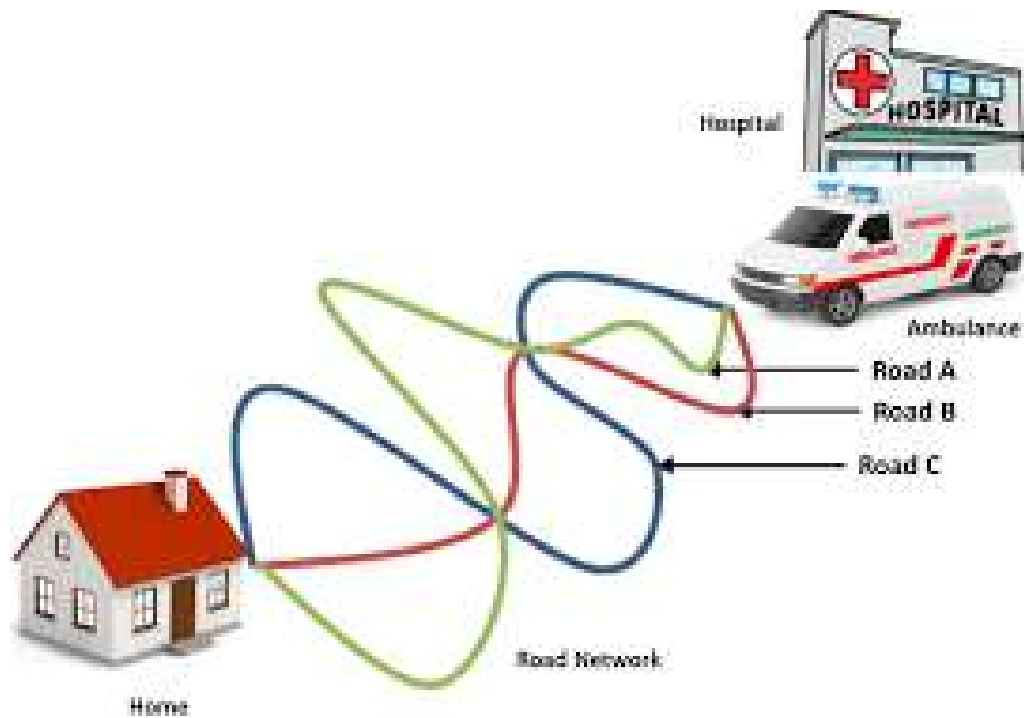


Figure 1: Image Reference: *Arabian Journal for Science and Engineering* volume 44, pages3831–3848 (2019)

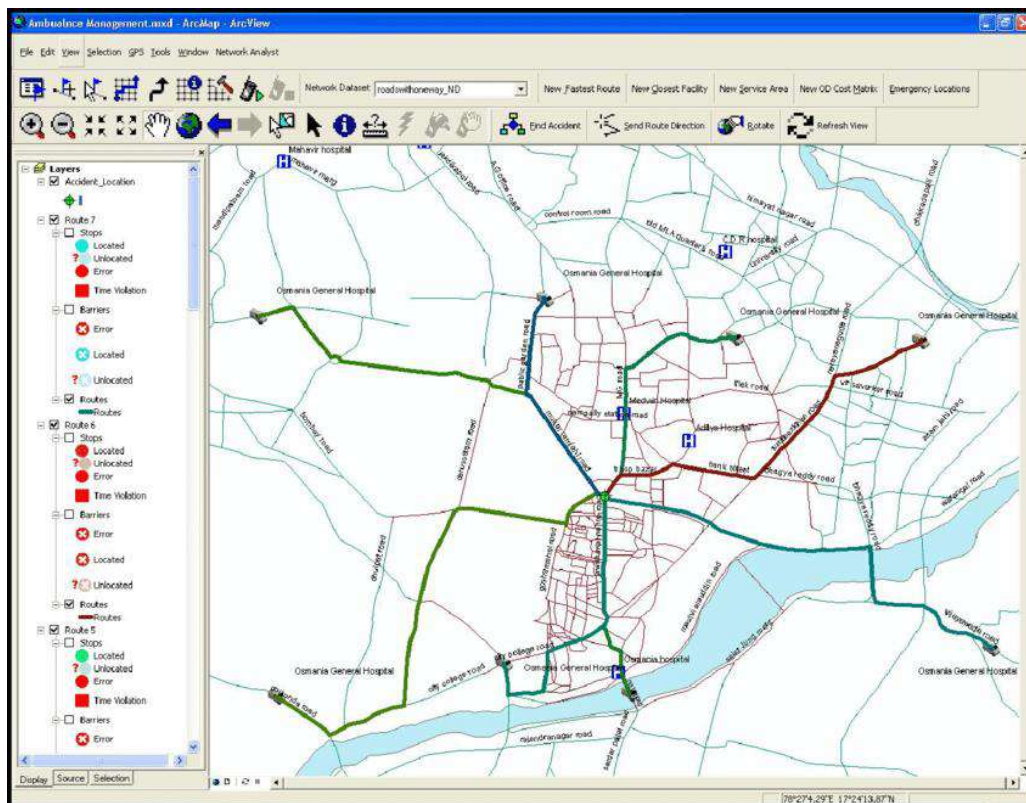
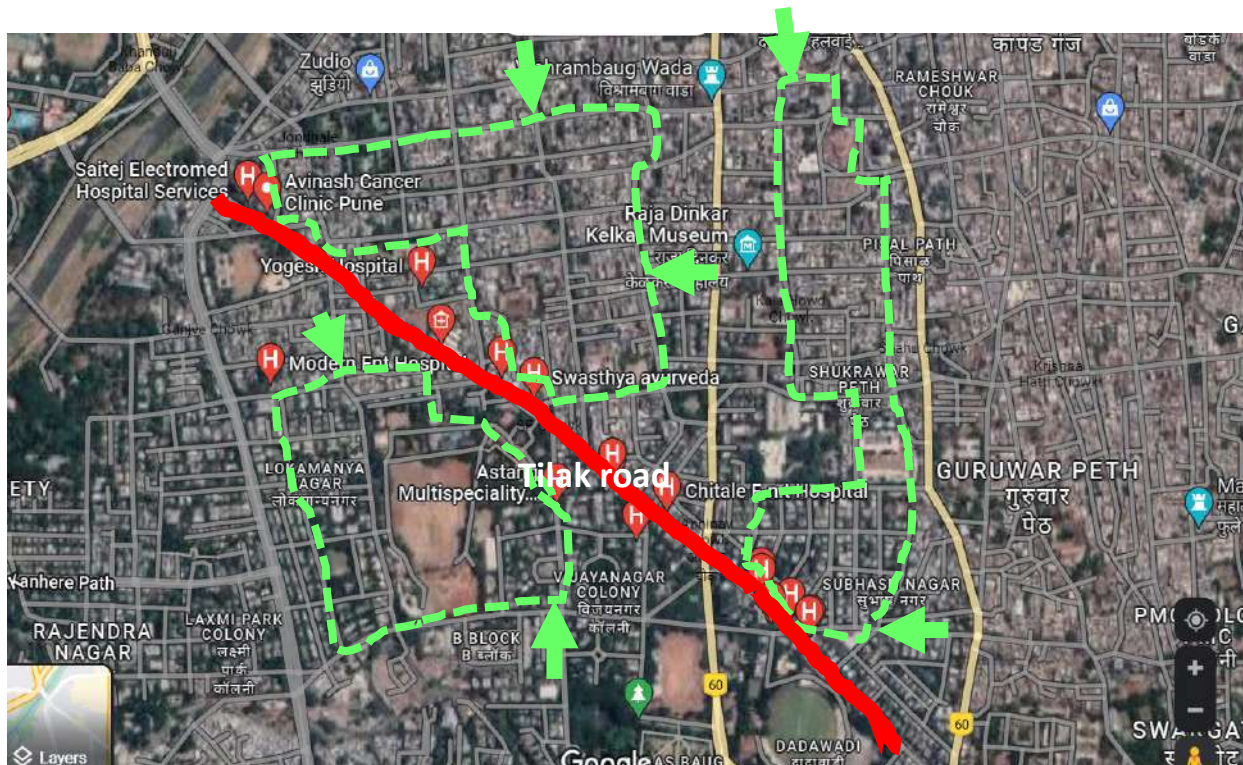


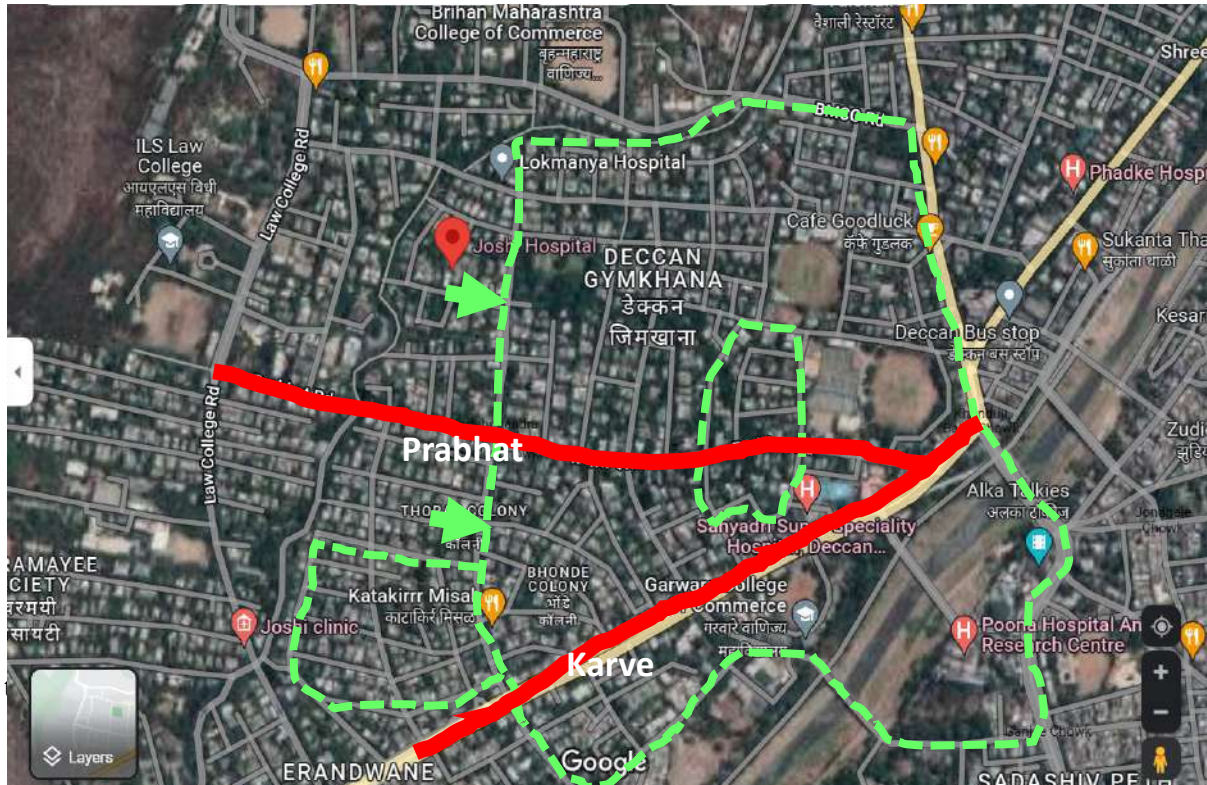
Figure 2: Image Reference Pasha, Imtiyaz. (2006). Ambulance management system using GIS.

Discussion:

Methodology of the study included identifying sample areas of the city to be representative of the city itself, identifying the major spine roads and points of hinderance for traffic flow, consideration of locations of hospitals on the major roads, surveys of the adjacent by lanes and documentation of probable lane loops. Visual surveys, distance documentation and mapping were done of the identified city areas, roads and by lanes for the ambulance routing study.



offices, shops, commercial outlets, restaurants about the road along with clinics and hospitals. Due to its almost straight geometry, the road is used like a spine road to connect and reach several destinations. Ambulances too take the spine like straight road to pick up patients and reach the hospitals. Most of the day, the Tilak Road is busy and crowded with mixed traffic including buses, cars, autorickshaws, motorcycles and cycles. Many a by lane and smaller roads meet the Tilak Road at various points along its length. Signals at key junctions help control the traffic flow and are useful especially during school hours when the school buses ply on Tilak Road. The Tilak road is always maintained and kept in prime condition to reduce the accidents occurrences on it. All these measures though help the flow of the traffic, there are times during the peak hours, day and night when Tilak Road gets jammed at different locations. Manoeuvring an ambulance during peak hours in the crowded traffic is time taking. It is seen that the use of the adjacent lanes and by lanes would prove useful during these times as it would save time and avoid getting stuck in any jam. But for the potential support by lanes to be efficiently used, the identified by lanes need to be maintained hindrance free just as the main road is maintained. This would allow the use of the selected by lane loop by the ambulance during peak hours for a faster lifesaving commute instead of taking the straight Tilak Road which is full of slow-moving crowded traffic.



A similar case of two major road in the city of Pune was studied. These roads pass through residential area and have hospitals, colleges, schools and commercial setups abutting them.

The two roads under consideration are both almost straight and have a network of well planned by lanes. The loops shown in green in Figure 4 are the suggested loop routes for the ambulance to save time in spite of the obvious slight increase in the distance as compared to the straight route of the main roads itself. The main road though straighter have crowded mixed traffic at most times which makes the commute through the empty by lanes quicker. The quickest path possible would depend on the location of the patient and the destination hospital the ambulance would need to travel to.

Conclusion:

Ambulance routing needs critical attention to save precious time. Efficient use of ambulances and road networks need critical attention and focus to carry medical personnel and patients as large number of people require medical aid throughout the day and night and ambulances usually prove to be a scarce resource. Routes used by ambulances in key areas of the city were studied for service completion time and the delays faced, It was observed that main spine roads were majorly a part of the ambulance routes due to their comparative straightness and long lengths. But it was seen that the use of a network of the inner adjacent by lanes would help to save time and hence lives with quicker efficient ambulance service time spans. Adjacent loops of lanes should also be considered as a part of the ambulance routing network and should be upgraded with appropriate maintenance at all times. Simple modifications in the ambulance routes to include the by lanes as a part of the network would result in optimizing the ambulance service time.

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Cybernetics and Architecture, A literature review of the journey

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Abstract: This paper has explored the origins of cybernetics. Its theories of the correlation between cybernetics and architecture. It examined the development of the discipline of cybernetics in the field of architecture. The core structure of cybernetics is reviewed. This paper attempted to discuss in depth the field of cybernetics. It does examine and reviews different perspectives and compares them. The paper explores new directions for implementing cybernetic techniques to building modern & interactive architectural designs. At the end of the paper, it has looked into the future possibilities that cybernetics can bring to the field of architecture. The conclusion drawn is, cybernetics will have a more apparent impact on the future of design. It concluded that based on current technological trends such as Artificial intelligence (AI) and Augmented reality (AR) new set of tools will be developed for the field of architecture. These technologies will play an important role in cybernetics related to architecture.

Keywords: Cybernetics, Architecture, Correlation, Evolution, Adaptation

1. Introduction:

Introduced in 1948 by mathematician Norbert Wiener, refers to the study of "control, understanding, and communication in the humans or animals and the machine." (Coen, M. H. 1998). Cybernetics, a science that appears to be set on universalism and aims to reshape all other sciences in its image, continued the Victorian-era goal of a perfectly regulated political economy run by a perfectly regulated science (Massey, J.2006). Cybernetics name is not a common term that is used in everyday technical conversation. Now cybernetics term has replaced its name with information theory. This paper tries to explore the origin and evolution of cybernetics. By looking into the relationship between cybernetics and architecture we try to formulate ideas. Those Ideas help us to see, in which direction cybernetics and architecture trends are heading.

2. Aim and objective:

The aim of paper is to get better understanding of current state of Cybernetics in relation to Architecture and design and then compare my findings. Based on the conclusion drawn from the findings, it tries to estimate or predict the direction of trends. The ultimate goal is to offer suggestions and predict potential areas to work on. In other words, by conducting this review we learn from what

has been done till now. At next step look into the current technologies, we try to connect the two and find possibilities we can explore and come up with ideas and suggestions to work on.

3. Methodology:

This literature review paper attempted to follow certain steps to provide a good understanding for the reader of Cybernetics in general and its relation to architecture.

First, it looks into the history of cybernetics and what has been established originally

Then it explored the basic core principle of cybernetics

After that, it utilized already existing data or facts and analyse it to provide a critical assessment of the sources

It attempts to foresee possible future as well as come up with a possible new direction to explore. This mean can be accomplished by seeing the current trends and comparing them critically to extend possible

This paper tries to look into it from different perspectives and see where are shortcomings and dark areas where things yet need to be improved. Simply due to the new possibilities of current expanding technologies what seems possible which seemed not practical a few decades ago

In the end it concludes the whole topic from the above steps

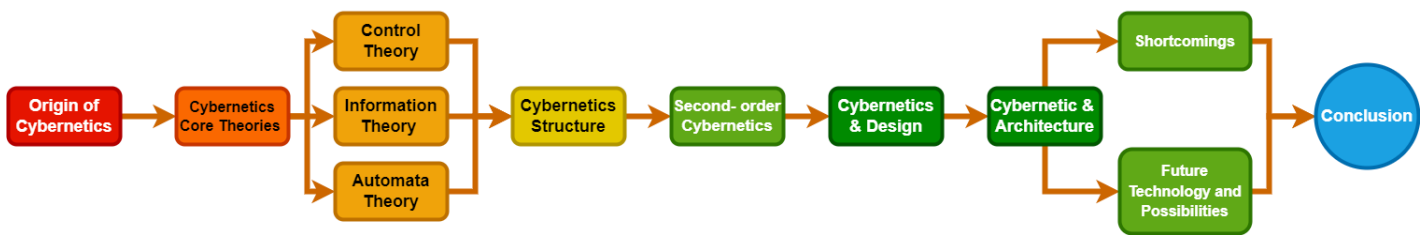


Figure 1. Methodology

4. Literature Review:

4.1 The origin of cybernetics:

What currently is addressed as cybernetics has a different origin. Cybernetics emerged as a by-product of a problem. when a group of esteemed researchers came together in Mexico to work on several projects related to the Second World War. They came to realize that it was challenging for them to have serious productive conversations with one another, exactly because of their prominence in various disciplines. Hence, they decided to choose a subject that was of general interest to all, but nobody's area of expertise. The reason that made this decision more significant was the fact that they had nothing to prove. They decided to talk about the nature of control (Apter, M. J., & Wolpert, L.1965). The modern term "cybernetics," introduced in 1948 by mathematician Norbert Wiener, refers to the study of "control, understanding, and communication in the humans or animals and the machine." (Coen, M. H. 1998). He was exploring the possibility of learning machines. Learning machines are systems that can learn from the mass of data without being instructed step by step by sampling and showing the patterns to them. The logical step to start was to study natural machines (animals) hence they could understand better biological cybernetics and another aspect of cybernetics. (Apter, M. J.1969).

Computer science, network theory, neuroscience, engineering, and biological principles are all integrated with the discipline of cybernetics (Fischer, T., & Herr, C. M.2019). Stafford Beer has explored the historical process of the origin of cybernetics up until the 1960s and his conclusion is the relevancy of cybernetics will increase with the advancement of technology and time. (Apter, M. J., & Wolpert, L.1965). The evolution of cybernetics has been discussed further in this paper.

4.2 Feedback, Control and Cybernetics:

One of the core ideas of cybernetics is the critical concept of the feedback loop. The feedback loop, which media theorist Alexander R. Galloway simply defined as "an internal message loop in which messages originating within the system also impact the operation of the system," is arguably the most important term in cybernetics. Because of the dynamic change that arises from this, systems use feedback to reduce imbalance and strive toward homeostasis (Kia, A., & Mahdavinnejad, M.2022). Feedback control is rooted in the mechanical system according to the Otto Maier which we can find the earliest sign of them in the third century B.C. in a water clock made by Greek inventor named Ktesibios (Kline, R. R 2015). Feedback loops are divided into positive and negative feedback. A system may adjust itself, maintain equilibrium while adjusting for changes, and, in theory, evolve with the help of a negative feedback loop. At first, the cybernetician's position in the system's connection was that of an outsider who served as a literal controller (Kristina Boychenko,2017).

4.2.1 Information Theory:

Information theory, or communication theory as it is sometimes called, has been formulated in several ways, but it is likely correct to state that Shannon and Weaver's is the most generally used and recognized today (Marinescu, D. C.2017) Weaver himself who from the field of communication engineering has commented "This is a theory so general that one does not need to say what kinds of symbols are being considered-whether written letters or words, musical notes, spoken words, symphonic music, or pictures. It is dealing with the real inner core of the communication problem. In other words, the core problem of communication is the same regardless if it is a special type of problem. Also it is regardless of what the communication mode is. (Marinescu, D. C.2017).

4.2.2 Automata Theory:

Automata theory may appear to be less essential to the concept of cybernetics than information and control theory, but in reality, it has been integral to the growth of cybernetics. Its characteristics may be best appreciated by comparing it to information theory. Automata theory is a branch of met mathematics that focuses on proof, whereas information theory is primarily a branch of probability theory and is concerned with quantities. Maybe we should refer to automata theory as "the logic of systems" (Mitchell, & Hansen,2010). In the modern sense, an automaton is essentially a machine or system that is deterministic and does not require the application of probability ideas. An automaton is an ideal or archetype in automata theory, similar to a diagram in Euclidean geometry where we do not need to account for the thickness of the lines. (Marinescu, D. C.2017). In simpler words, automation is a problem with nature in which forms are not relevant but the core idea behind it. It can appear in different forms but the principle behind it is relevant and not the form.

4.3 The structure of cybernetics:

In past, the impression may have been given that all of the cybernetic research is devoted to developing various mathematical and logical ideas for their own sake. If this was the case, cybernetics

would not have the pervasive influence that it is coming to have across a wide variety of subject matters including engineering, biology, physiology, medicine, psychology, psychiatry, anthropology, sociology, economics, architecture, and business management. There is sort of a two-way process involving abstract ideas from cybernetics becoming applied in various concrete situations. The latter sometimes gives rise to further developments in theory (Mitchell, & Hansen, 2010). We can say this is a two-way relation which both influence each other.

At the level of physical systems, there is also a kind of reciprocal interaction because, as hinted by its name, cybernetics is in part a study of the interactions between machines and animals. On the one hand, biological processes are investigated to learn how to create more complex (purposeful, intelligent, adaptive, and flexible) machines for different applications. On the other hand, research into how engineering systems, such as computers, accomplish different goals (as well as the creation of models of specialized hardware), may shed light on how animals accomplish comparable goals. (Mitchell, & Hansen, 2010). Thus, ongoing collaboration between the study of engineering and biological systems is advantageous to both disciplines. But typically, the more abstract concepts of cybernetic theory will operate as a mediator in this relationship. In accomplishing this, cybernetics elevates robots to the level of man rather than lowering them to that of "machines" (in the traditional sense). (Mitchell, & Hansen, 2010).

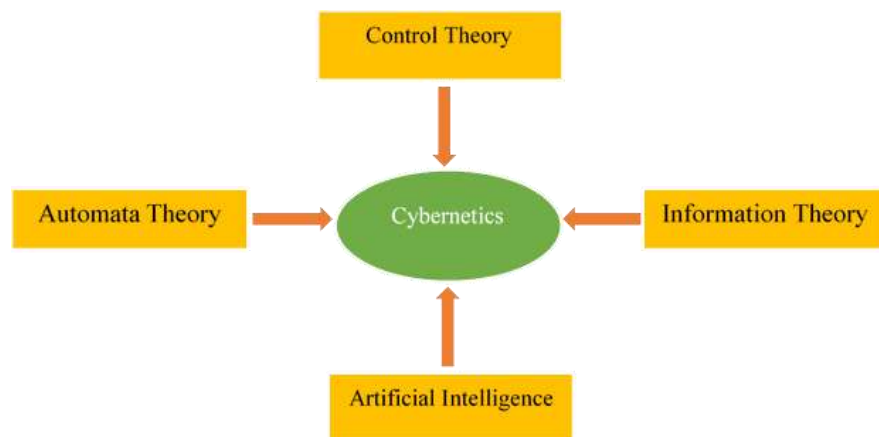


Figure 2. Basic structure of cybernetics

4.4 Second- order Cybernetics:

Cybernetics has always been intrigued by the parallels between machines and self-replicating, biological systems. The obsession with cutting-edge computer and control technology in this post-war era has tended to draw attention to the engineering method, in which the system designer decides what the system will perform. The remaining cyberneticists, however, felt the need to clearly distinguish themselves from these more mechanistic approaches by focusing on autonomy, self-organization, cognition, and the role of the observer in modelling a system after the control engineering and computer science disciplines had become fully independent. This movement was known as second-order cybernetics at the beginning of the 1970s (Hamilton Frazer, J. 2001). Heinz von Foerster coined the term "second-order cybernetics" as "the cybernetics of cybernetics", and Gregory Bateson, Margaret Mead, and Gordon Pask were among those who supported it. According to N. Katherine Hayles, second-order cybernetics is concerned with the interaction between the system and the observer, whereas first-order cybernetics was focused on the flow of information within a system (Lagerspetz, K. Y. 2001).

5. Cybernetics and Design:

The cybernetic philosophy views design as a creative epistemic activity. In terms of design, cybernetics makes a lot of self-adjustments. Each of these modifications represents both a break from the ideals of natural science and an approximation of design as many designers understand it. In addition to these modifications, the expansion from first-order to second-order cybernetics has remained constant. Many of the terms used in early control engineering to characterize elements of out-of-control processes, such as feedback, variety, necessary variety, constraint, error, and so on, turn out to be appropriate. (Shannon, & Weaver, W.1998). Design cybernetics, according to Thomas Fischer and Christiane M. Herr, does not provide a methodology because its goal is to promote rigor that is independent of established practices. In essence, it strives for more choices and enjoyment in the relationships between our individual and collective identities while avoiding the exercise of restrictive control over the other (Shannon, & Weaver, W.1998, Torisson, F.2017).

The next phase in design was integrated design cybernetics. It does involve people and incorporates their feedback into "intelligent" digital systems. Interactive working methods are now commonplace in many industries. Online personalized advertising, social networks, and multimedia are all built on potentially conversational processes. The future may very possibly be shaped by automated artificial forms of conversation as a result of the global digital revolution (Torisson, F.2017).

6. Cybernetic and Architecture:

There have been several contributors in the field of cybernetics who has long lasting impact on the field. I have reviewed and explored their works from lens of architecture and cybernetics.

Cybernetics had a significant impact on architecture in the second half of the 1960s. According to Jonathan Massey's suggestion in a conversation about the cybernetic features of the US pavilion for Expo 67 in Montréal, can regard architects like Buckminster Fuller as members of the cybernetics club (Massey, J.2006).

6.1 Gordon Pask:

Gordon Pask played a key role in the development of the discipline of cybernetics in the field of architecture. In an article, first published in *Architectural Design* (1969), He argues that systems in this intellectual field are, in theory, founded on regulation, control, adjustment, and purpose, filtered through the use of feedback (Frazer, J. H.2007). His argument is based on the notion that architects are fundamentally system designers who, over the past 100 years or so, have been compelled to take a growing interest in organisational or nontangible systems features such as development communication and control (Frazer, J. H.2007). According to Gordon's historical examination of the evolution of architectural theory, theory prior to 1800 simply served as a "abstraction from the art of building." The intelligent application of architectural guidelines could resolve issues. As a result, despite designing systems, architects did not need to view themselves as system designers (Frazer, J. H.2007). In architecture, cybernetics is being developed as a new theoretical foundation and as a metalanguage for critical discourse. Additionally, urban growth can be modelled as a self-organizing system, and cybernetics is advanced for its capacity for prediction (Frazer, J. H.2007).

There is a part of research in architecture during the middle of the 20th century that proposes as its object of study a rather different goal than what might be considered to be within the perspective of historical work, its aim is to provide a realistic criticism account of the formation of some aspect of contemporary architectural discourse. This method of scholarly writing focuses on a certain idea, moment, or group of ideas that are present in architectural writings over the last fifty years and follows their progression through numerous discursive spheres up to the present (Gagliano, R., & Gehl, J.2008). Christopher Hight, author of the "Architectural Principles in the Age of Cybernetics" "explains things, practices, and declarations of architecture in a way that raises new sets of concerns than those which dominate standard historical narratives" through the use of a critical technique (Gagliano, R., & Gehl, J.2008).

The use of cybernetics in the built environment, as either a theoretical tool or actual technology, piqued the interest of Reyner Banham, Cedric Price, Yona Friedman, Nicholas Negroponte, the members of the Archigram group, and the Greek architect Takis Zenetos. In their ideas and writings, they incorporated cybernetic notions like indeterminacy, information feedback, self-regulation, and adaptation to imagine open-ended user-driven environments. Similar concepts returned in the 1990s, when the prevalence of digital devices made it possible to once again combine design with computer systems to create environments that could adapt to changing needs, even though their proposals were largely unrealized experiments (Glanville, R. 2007).

6.2 Interaction Design & Cybernetics:

Gordon had previously experimented with interactive environments, especially the "Musicolour" system he and Robin McKinnon Wood had created, and he now had the chance to show it to a larger audience. At the Institute of Contemporary Arts, Jasia Reichardt organized the astonishing show "Cybernetic Serendipity" in 1968 (Wiener, N.1961). The goal of interactive architecture, an emerging phenomenon, is to address the environment's variety of forms. A better link between modern man and architecture is possible thanks to the rapid advancement of technology, artificial intelligence, and other human achievements. Architecture must keep up with this trend. Interaction is an indicator of the ability to have live conversations between people and structures (Yiannoudes, S.2016).

Experimental success in generating a dialogue between users and their built environment has raised hopes for the rapid development of fully integrated interactive applications for buildings. Fully interactive spaces and buildings have the capacity to physically alter form and space. One may argue that the primary goal of interactive design in architecture is to determine users' needs and influence their decisions while also responding to those demands (Wiener, N.1961).

It is difficult to overstate the value of interactive architecture in a society that is rapidly modernizing and embracing new, interesting technologies. Benefits include those that are economic, social, psychological, and physical. There is little doubt that it will continue to be used in more and more modern architecture. When it comes to optimising a building's structural performance, interactive architecture is especially advantageous because it deals with objects rather than people.

The subject of emotions in relation to architecture is still quite complicated because of how differently people interpret space, differences in scale, and technology restrictions. To deal with emotions in architecture, however, not in a subjective, almost artistic way, but to conduct scientific research about emotive architecture and the effects of the relation between architecture, and user are new fields that need to be studied more. Some have attempted to use "Kansei method" to conduct such research (Yiannoudes, S.2016). The term "interactive architecture" is more general and covers a variety of architecturally related emerging streams.

7. Shortcomings:

The technological advancement that happens in certain fields is generally blindly followed by the aligned fields. The same goes for Architecture. We follow the technology considering what's best for the region we live in. This can lead to complications or missing out on obvious and more relevant answers which can help us apply better solutions locally. We have been ignoring how we can build technology around geology considering any particular region. This is an untapped potential that we can work on. The thinking framework and attention to this particular problem need a lot of development and attention. The use of programming & networking shall be the key to the design process which can help us to think beyond interactive design solutions.

Due to budgetary constraints, the majority of architectural projects do not call for ongoing post-occupancy studies.

Cybernetics have looked upon something for the far future and not as something that can be achieved at the present. Some part of it was due to technical limitations of the past, but despite the breakthroughs in many fields such as AI and AR the thinking remains the same. It is the best time to try and revisit the ideas where we thought things are not possible and reevaluate that thinking

8. Future Technology and Possibilities:

The rapid expansion and growth in fields such as Data Science and A.I. made it easy to see that these new technologies and tools are entering the Architecture domain. One of the places they can be really useful is interaction design in architecture. It is worth to mention biomimicry and new advanced tool can be implemented in design and execution in the architecture field.

Emerging trends in the industry, such as virtual reality (VR), and artificial intelligence (AI) are the next obvious step to take. There are high potentials that can be worked on in near future in relation to architecture and artificial intelligence. From visual assistants to the Designer or user to interactive adopting systems in the buildings for the increase of comfort.

Kinetics, responsive, intelligent environment, and smart, responsive architecture are examples of evolutionary architectural trends. Technologies such as IoT (Internet of Things) can lead to more efficient and smart decision-making and in long run to a better experience with interaction design.

Right now every smart device which we install in the homes collects a huge amount of data which can lead to a deeper understanding and personalizing the experience of the user and space overall. There is a long way ahead in this field and some of its challenges are common with other fields such as AI when it comes to privacy and to what limit we should let our lives be in hands of AI.

This is not a new challenge but is ever evolving, for example, Michael H. Coen has done a series of experiments in 1998 that "led them to re-evaluate many of their initial assumptions about highly interactive environment" and the way it has to be designed. In short, it is interesting to work on such problems and the ever-changing nature of these problems will lead us to more advance spaces.

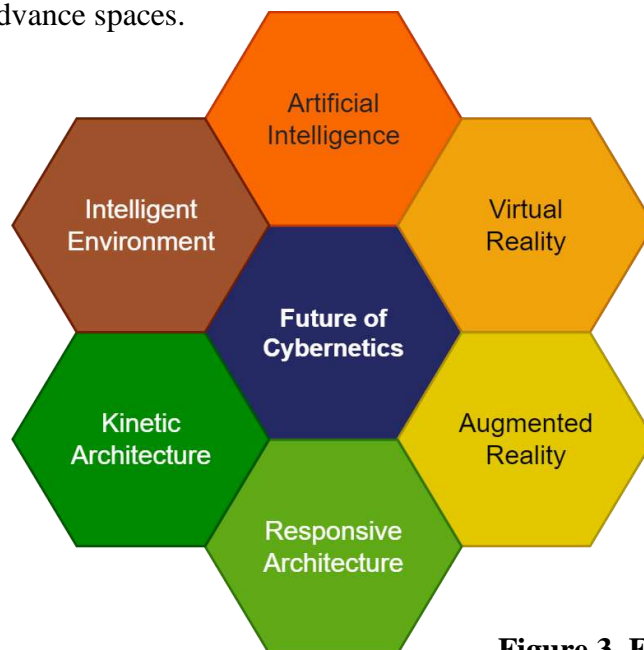


Figure 3. Future of Cybernetics

9. Conclusion:

This paper looked into the origin of cybernetics, and its relation with architecture at present and suggested some future trends of cybernetics in relation to design and interactive design

The study and analysis of cybernetic thinking with respect to architecture as an environmental, social, and cultural device is an ongoing trend that has been paid attention to more

With respect to the current technological leaps in fields such as AI and machine learning these technologies have the potential to merge with current practices in architecture. There is a potential that this process leads to new components for the design process itself. This new component may calculate, determine and predict processes and results in new ways. These new dynamics can have a high potential for changing the architecture field

The hopeful future of cybernetic architecture will enable more flexibility instead of a single one-off option that must be used in a design, multiple design options can be adjusted according to the needs of a project

It has observed that cybernetics and interactive design seem to be two sides of the same coin but based on the literature review and current technologies they will become more distinguishable and independent yet highly correlated in the future. In short, it can be said that due to the ever-changing nature of some technologies such as AI, this idea of independence irrespective of user interaction is not far from speculation. That being said, this argument needs more exploration

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Pune: Identifying important nodes to adopt an integrated multi- modal transportation system.

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Abstract: Roads are the arteries of an urban city. To a great extent they frame the identity and character of the city. A good transportation system brings overall development of the country and is a medium of social exchange. As rightly said by Gustavo Petro the mayor of Bogotá, Columbia, “A developed country is not a place where the poor have cars, It’s where the rich use public transportation system”. Pune is ranked as the second most livable cities in India. This in turn has led to significant rural-urban migration which constitutes of quality education and good employment. As the economic status of the population increases the rise in ownership of private vehicles is seen which has led to traffic congestion in the city. Without the provision of an efficient management of public transportation system this number will keep on increasing. To cater to this problem, understanding the multi-modal public transport is very important, which will help in reducing the travelling time, increase efficiency, improve public satisfaction and reduce traffic congestion on roads. To reduce traffic congestion on the roads and promoting the use of public transportation, a system that integrates the different modes of transportation system such as buses, rickshaw, trains, metros could be adopted. This system not only makes travelling a better experience but also makes it efficient, user friendly, economic and sustainable. The scope of the study is to identify different nodes of the Pune city which are the important hubs of public transportation where a significant amount of interchange between different modes of public transportation is observed where such an integrated system could be adopted.

Keywords: Public transportation, Multi-modal, Identifying Nodes, Integrated System.

1. Introduction:

Pune is famously known as the ‘Oxford of the East’, The Queen of Deccan, because of its rich education and booming IT companies which has attracted many students and job seekers. This has led to an increase in the population of the city. (Leducq). The city has developed into a booming global educational hub in recent decades, with approximately half of the international students seeking admission in Pune. Research institutes of information technology, education, management and training attract students and professionals from India and beyond seas. (Kalam) According to the 2011 census Pune’s population is approximately 31 lakhs, it is the seventh most populous city in India. (Pune city population census 2011-2022).

Though Recently Pune is also famously known as ‘The Two-wheeler capital Of India’, the number of registered vehicles according to RTO are 38.88 lakhs in 2019 which makes Pune the first city to overtake its human population. (Rajan). With the road widths still catering to the population needs that pertained almost twenty to thirty years ago where owning a car was merely a sign of wealth to now every middle class household acquiring a two wheeler for every member of the family with a car or two for the family, the problem of congestion is creating a pressing concern. The widening of the

roads solely cannot be a fix to this problem as the core area already being developed has very little to no room for widening the road as it leads to minimal pedestrian belts resulting in jay walking. (Gupta)

The problems arising due to this situation may include regular traffic jams on the roads and intersections which deteriorates the quality of travel. Out of the total traffic on the road 75% traffic consists of low occupancy vehicles that include two- wheelers and Four -wheelers. The buses that are provided are over-crowded are no longer in routes. The modal split is 46% which is expected to be in between 70% to 80%. In the course of recent trends these figures are seen to be more towards decline. Inefficient and unsatisfactory user experience towards the public transportation system. This also has led to an increase in travelling time. The overall average speed is about 13.5 km/ph. Due to narrow roads high traffic congestion is observed during peak hours. (Chib)

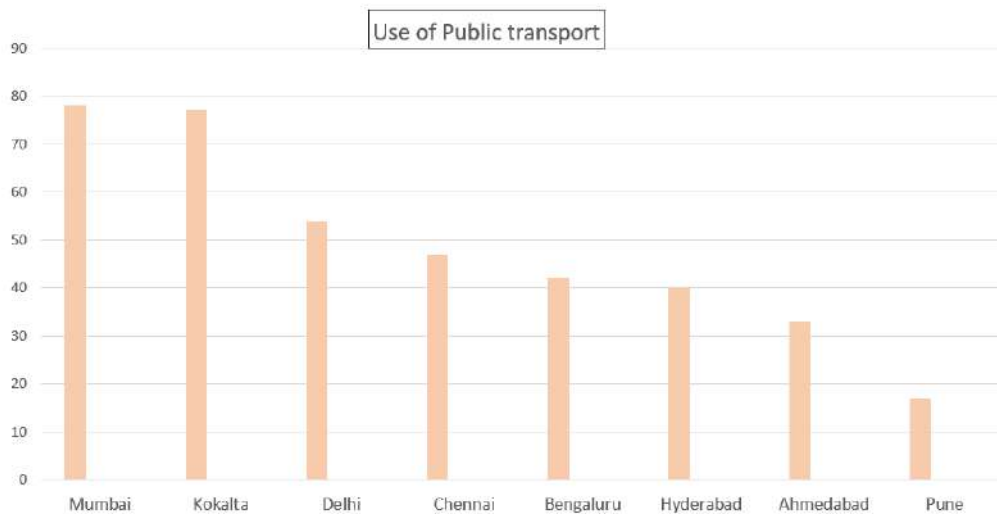


Figure 1: Public Transportation use in most populous cities (Seetharaman)

Out of the total population of Pune City (31 lakhs approx.) only 10.89 lakh use public transportation (Sengupta). Comparing to the other top ranking populous cities in India, Mumbai stands to have the highest percentage (78%) of population using public transportation, followed by Kolkata -77%, Delhi – 54%, Chennai – 47%, Bengaluru - 42%, Hyderabad – 40%, Ahmedabad- 33%, and lastly holding the eight position is Pune with only 17%. (Seetharaman) (Refer to Fig.1)

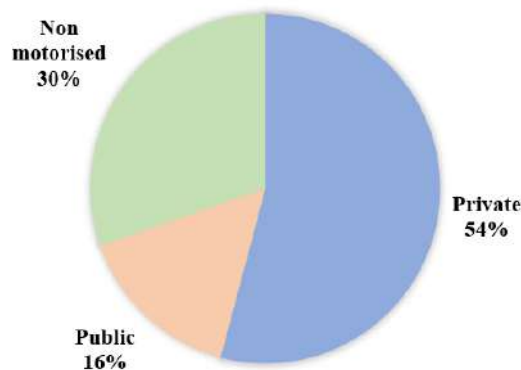


Figure 2: Modal split of Pune (Pune Mahanagar Parivahan Mahamandal Ltd)

The modal split of Pune shows that 17% use public transport, private transport is used by 59% and non- motorised transport use (walking and Bicycle) is 33%. (Pune Mahanagar Parivahan Mahamandal Ltd) (Refer to Fig. 2)

Figure 3: Distribution of trips (Supekar)

Purpose of Travel	% Share
Work trips	40.70
Educational trips	41.57
Other (business, social visits, recreational, etc.)	17.73
Total	100.00

The population of Pune comprises of mixed age groups and professions. This population travels every day to their desired destination having various purpose using public transport. The distribution of trips in Pune is categorized between work trips, educational trips, and other (business, social visits, recreational). (Supekar) (Refer to fig. 3).

Promoting the use of public transportation along with the amalgamation of an efficient system can be proven as an effective way in reducing traffic congestion as they have a higher occupancy rate than the private vehicles. In order to compete with the private vehicles some important factors need to be considered. The factors that contribute towards the use of public transportation system include-

1.1 Efficiency.

The user who is travelling by the means of public transport has to access the service through the system of stop. These stops should be located at a considerate distance from where one can walk or use any other means. Therefore, the location of the stops becomes a crucial factor of efficiency. Further the availability of transport at regular intervals and in multiple numbers has to be observed to avoid over-crowding. The routes of the buses should be properly mapped keeping in mind the land-use of the city and where most of the commuters are travelling to. In case of an exchange of a transportation is required it should be carried out smoothly without any stress to the user.

1.2 Affordability.

The fare of any transportation depends on the fuel costs, the labour market for commercial drivers, customer loyalty, vehicle capacity, government regulations, etc. In Pune the average cost of travelling in a bus is Rs. 32 for a distance of 20 kms. Whereas the fare ranges from Rs. 10 to Rs. 65 for a distance equivalent to 2 kms to 60 kms. There is also a system of monthly pass that ranges from Rs. 600- 1800 depending on the route. Children have the benefit of paying a half ticket on the fares. For a middle-class user, the fares are affordable. (Pune Mahanagar Parivahan Mahamandal Ltd) For rickshaws the minimum fare starts from Rs. 21 for the first 1.5 km, thereon it increases to Rs. 14.20 for every km. This option thus becomes a little steeper on the affordability but the users do have the option of share rickshaws with maximum capacity of three person which divided the fare among three users. (Bengrut)

1.3 Time Consumed.

The hassle of every day leaves the commuters with the impression of getting to the desired location as quickly as possible without wasting a lot of time in travel. Travelling through public transport is therefore neglected due to lack of efficient planning in routes which takes the user longer time to reach the destination directly through the shortest possible route or the unavailability of transport at regular intervals and the unpredictability of the time hence required.

To narrow down the scope of research and understand the public transportation available in Pune city the busiest areas occupied by public transportation in Pune city were studied. The busiest-

1.3.1. By PMPML(Pune Mahanagar Parivahan Mahamandal Ltd.) City bus.

City buses in Pune are run by the PMPML. Although the vehicles are crowded and smoke-belching, the network is very extensive. Almost all parts of the city are connected by the PMPML city buses. Major city bus stands include Corporation, Shivaji Nagar, Swargate, Kothrud depot, Nigdi, Hadapsar, Katraj and Deccan. Shivaji Nagar is believed to be the busiest bus stand in the state of Maharashtra. (Pune Municipal Corporation)

Pune Mahanagar Parivahan Mahamandal Ltd. (PMPML) is the public bus transport service provider in the Pune Metropolitan Region. PMPML has a daily ridership of 8,07,511. It plies 1000 buses in a given day, on 282 routes. PMPML has 10 depots (Swargate, Nerveer Tanaji Wadi, Kothrud, Katraj, Hadapsar, Marketyard, Pune Station, Bhakti Shakti (Nigdi), SantTukaram Nagar (Pimpri), Sadguru Nagar (Bhosari) and 66 bus stands for the operation of buses. PMPML plies on 282 routes and makes 21,998 trips per day. (Pune Mahanagar Parivahan Mahamandal Ltd)

Central Institute of Road Transport (CIRT) recommends an ideal ratio of 40 buses per lakh of population. For PMC with a population of 30 lakhs, this implies having 1,200 buses. Currently the PMT has about 850 buses, of which only about 700 are roadworthy. PMT thus needs at least an additional 500 buses. This shortage has an impact on travel choices by people. (Mathews)

1.3.2. By auto-rickshaws.

There is also a huge army of three wheeled rickshaws. There are some prepaid rickshaw stands at Shivajinagar, Swargate Bus Depot and Lohegaon Airport. (Pune Municipal Corporation) In 2007, auto-rickshaw constituted 3% of total vehicle population and constituted 11% of modal share (in terms of trips) among the motorized road transport modes. Auto-rickshaw handles about 5% of work trips, 17% of education trips & 23% of shopping, and recreational trips. (Mathews)

1.3.3. By suburban rail.

The Pune Suburban Railway connects Pune to Lonavala through Pune station, a small town on-route to Mumbai. (Pune Municipal Corporation) The Electric Multiple Unit (EMU)-local train service is being provided by Central Railways since 1978. It runs on broad gauge and there are 17 stations between Pune and Lonavala. It covers a distance of 63km in about an hour and a half. The daily ridership is about one lakh. (Mathews)

1.3.4. ST – State Transport (MSRTC)

The Maharashtra State Road Transport Corporation abbreviated as (MSRTC, or simply ST), is the state run bus service of Maharashtra, India which serves routes to towns and cities within Maharashtra as well as to its adjoining states. It has a fleet strength of 18,449 buses that ferry 8.7 million passengers daily. (Maharashtra State Road Transport Corporation) Depending on the bus the average fare for every 6 km is 15 Rs. (Maharashtra state road transport corporation)

2. Objective of the research

The increasing congestion, increasing travelling time, declining quality of air are major challenges in front of Pune City. In order to promote the usage of public transportation a more efficient integrated system can be adopted in Pune to satisfy the needs of the commuters who take one or multiple modes of transportation every day. While travelling through public transport we either start by taking a rickshaw to the bus stop then boarding a bus from a major stop from where the majority of buses are available through various routes to the desired destination. This questionnaire aims in identifying the major stops (nodes) from which a user either changes his mode of transportation from a rickshaw to bus, private vehicle to bus, bus to another bus, bus to train etc. from where transportation is available through majority of routes. The research aims to identify the spectrum of users, the starting and end points of their journey, their multi-modal pattern and the important nodes in the city which are the harbours of the multi-modal system. With the help of the identified nodes, we can recognise the need for such an integrated transportation system and take preliminary steps towards the betterment of the public transport in Pune City.

3. Literature review

In many cities in developing countries rapid population growth has meant that housing has developed in areas inadequately served by public transport services. This can have an effect on the quality of life of the residents of these areas in terms of access to employment, shopping and medical facilities. Before resources are allocated to increasing public transport, it is necessary to discover what improvements need to be made to the network. This can be achieved by undertaking surveys of passengers. Using a questionnaire to obtain data on frequency and mode of travel, problems incurred when making journeys etc. In addition, it is also necessary to obtain background information on the area studied and the culture of the society being examined, as these factors can have a major influence on travel behaviour. (A Astrop)

The case of public transport in Swargate, Pune is the demand of using private vehicles still far larger than on the using of public transport. This is one of the busiest areas in Pune. The Swargate connects Pune to various areas like Hadapsar, Fursungi, Dhankawadi, Bibwewadi, etc. Swargate as the city certainly has a great many problems, one of them is the problem of traffic and effective bus terminal is a solution. (Prof. Poonam Patil)

The study of Hadapsar Road gives the condition of traffic jam. It suggests the people to use public transport to reduce the traffic congestion. On street parking was observed and was suggested to be restricted. In the time of peak hour, the vehicles using the congested road should be charged, because of charging condition we may reduce the traffic congestion were the conclusions of the study. (Saurabh Pawar*1)

. **Figure 4: The traffic volume count towards Pune Station** (Kushagra Birendra singh Thakur)

Location	GunjanChowk
Direction	Towards Pune Station

Timings	Passenger Vehicles					Goods Vehicles		
	Bus		Private Vehicles			Trucks		
	Private Bus	Government Bus	2-wheeler	3-wheeler	4-wheeler	Light Trucks	Heavy Trucks	Dump Trucks
8-9 am	84	72	2415	495	1137	40	4	21
9-10 am	87	76	3130	447	1360	54	3	31
10-11 am	64	86	1715	439	989	112	8	26
11-12 am	46	69	1806	418	1285	110	3	23
12-1 pm	54	63	1930	495	833	97	6	9
1-2 pm	33	67	1797	355	780	84	8	6
2-3 pm	41	62	2208	319	773	77	5	4
3-4 pm	29	64	1673	379	743	70	6	0
4-5 pm	55	65	1907	415	1430	62	4	0
5-6 pm	83	63	2891	430	1477	47	2	3
6-7 pm	132	81	3146	481	1893	39	0	0
7-8 pm	81	82	3397	503	1769	23	1	1
Total	789	850	28015	5176	14519	815	50	124

Gunjan Chowk is a 2-way road heading from Pune Station to Ahmednagar and vice-versa. There is also a road which connects Pune Airport to Pune Station via Gunjan Chowk. So, in future there are a more chances of increasing traffic at the junction. The problem arising on the chowk is the development of traffic congestion during peak hours of the day (Refer to fig. 4). The traffic flow is most during peak hours of morning from 8am to 10am and evening from 6pm to 8pm. Apart from the road widening traffic persists in that junction. Traffic intensity is more and this being the one of the prime junctions in Pune city so it is essential to give any remedial solutions to this problem to reduce the traffic flow at Gunjan Chowk, Pune Station. (Kushagra Birendra singh Thakur)

One of the remedial solutions is transport integration. Transport integration is focused on: connecting different transportation modes operating in a certain transportation system, providing solutions to facilitate passengers and assuring safe, smooth and efficient flow of passengers. In general, the implementation of different transport integration solutions may result in the following benefits: reduction of travel times, transportation costs, traffic congestion and environmental pollution. Transport integrating solutions may improve the urban public transportation system accessibility and overall competitiveness as well as assure better utilization of different transportation means and infrastructure. (Katarzyna Solecka)

4. Methodology.

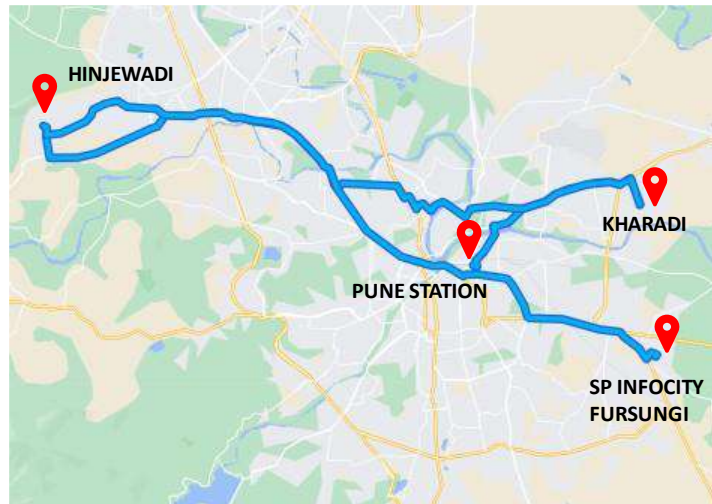


Figure 5: Connection of Pune Station to major IT hubs

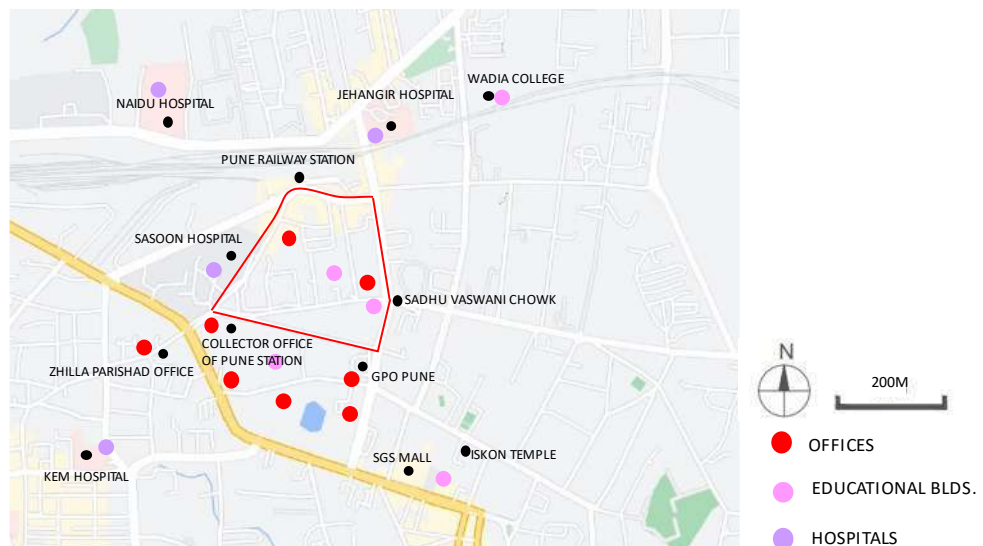


Fig. (6) Land use around Pune station

The study was conducted through a series of interviews to understand the, multi-modal journey of a user, their starting and end points of the journey, professions, to identify the important nodes in Pune City. The variables involved were identified with the help of literature reviews from various research papers and case studies. With the help of these variables a series of questions were curated. Initially a pilot survey of 15 respondents was conducted with the help of circulating the questionnaire through google forms to the respondents. Through the pilot survey it was analysed that a direct/offline approach to the users travelling through public transport was only accurate solution to ensure the viability of the research. Therefore, a shift from an online questionnaire circulation to an offline interview was adopted to get a better result. The main factors to analyse was that, on a particular route which is the node that becomes the centre for a multi- modal system. To identify a node a route had to be selected on which high flow of public transport was observed. With the help of study, it was derived which were the busiest route which narrowed down list. Further after the study of the development plan

of Pune it was derived that the major IT hubs were situated in Hinjewadi, Kharadi, Fursungi (Refer to fig. 5), one of the government hospitals in Pune that is the Sassoon hospital was situated near Pune Station, the government offices such as the Collectors' offices, The Central building, The Pune Zilla Parishad office etc. were situated in the perimeters of Pune station. Many schools and colleges were also observed in this area (Refer to fig. 6). Hence a route that connected all of these areas by public transportation was considered for the research. Pune Station was considered the centre to all these routes through which all of these areas were accessible. 60 respondents from different localities travelling through public transport passing through Pune station were interviewed during the peak hours of the day. The questions were categorised and split into 3 parts. The first part included understanding the user demographics which included the age, profession, working hours. The second section focused on understanding the travelling patterns of the users and their choices regarding their mode of transportation. The third section of the survey included users' subjective perception on the convenience of travelling, the parking facilities and whether they find the need for a more organised and integrated node which was collected by rating from 0-10. 0 being least satisfactory and 10 being most satisfactory. The interviews were conducted between February and March of 2022.

5. Results.

5.1 User Demographics.

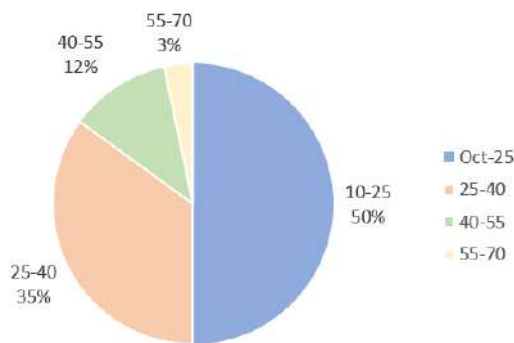


Figure 7: Age group

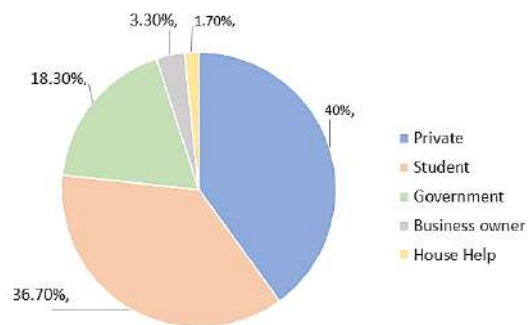


Figure 8: Professions

A total for 60 respondents were interviewed out of which 29 (48%) were female and 31(52%) were male which indicates that female passengers were approximately equal to male passengers. The age group of the respondents was taken in intervals of 10-25, 25-40, 40-55, 55-70, 70 and above. Ages from 10-25 accounted for the largest portion that is 50%, 25-40 contributed to 35% of the interviewees, 40-55 to 11.7%, 55-70 to 3.3% and no respondents were from the ages of 70 and above, which indicates that senior citizens do not find travelling through public transport comfortable.(Refer to fig. 7) The professions that corresponded with the interviewees accounted for 40% being from the private sector, 36.7 % accounted as students, 18.3% were government employees, 3.3 % were business owners and 1.7% accounted as house help.(Refer to fig. 8)

The working hours of the users ranged from 10am to 6pm for 40%, and 8am to 3pm for 25% of the users. Others fell into the 10am to 6pm range itself with minor 1/2 hours' difference.

5.2 Transportation

The types of transportation available on this route include bus, rickshaw, train, and ST. The respondents were using one or combination of either mode in one trip. 54 users prefer travelling through bus, 24 by rickshaw, 7 by train, 4 by ST, and 3 by the mixed used of private and public. To understand the mixed transportation of private and public, the users were asked about their preferred public transportation along with the private. Out of the 3 respondents that used mixed type of public and private, 2 preferred the combination of private and bus, and 1 preferred the use of private and ST.

To understand the trip length the users were asked about their starting and ending points of their journey. The bus and rickshaw users started their journeys from Ambegaon, Bhavani Peth, Bhekraingar, Balaji Nagar, Camp, Gighi, Hadapsar, Hinjewadi, Kalewadi, Katraj, Kharadi Kondhwa, Magarpatta Mundhwa, Pimpri, Pullgate, Pune Station, Saswad, Skirapur, Somwar Peth, Swargate, Talegaon, Viaduwadi, Vimaan Nagar, Wadgaon Sheri, Wagholi, Wakad and Wadia College.

Their journey ended to AFMC, Alandi, Aundh, Bhartiya Vidyapeth, Bhosari, Bhartiya Vidyapeth, Ghorpadi, Hadapsar, Hinjewadi Phase 3, Kharadi By pass, Karve Nagar, Kasba Peth, Katraj, Kondhwa, Market Yard, Nigdi, Pingale Vasti, Pune Station, RTO, Ranjan Gaon, Ruby Hall, Sassoon, Sadashiv Peth, Sadhu Vaswani, Shikrapur, Shivaji Nagar, Swargate, Sinhagad road, Vimaan Nagar, Wadgaon Maval, Wadia, Wakad, Wagholi, Wanavdi.

The users travelling by train travelled between Mumbai and Kondhwa, Shikrapur, Viman Nagar, Bhavani Peth, Mundhwa.

The user travelling from ST travelled between Shirur to Mumbai, Vimaan Nagar to Mumbai, Bhavani Peth to Mumbai, Mundhwa to Mumbai, Daund to Mumbai, and Satara to Vimaan Nagar.

5.3 Multi- Modal transport

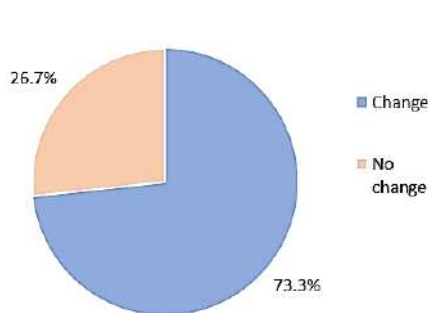


Figure 9: Change in transportation

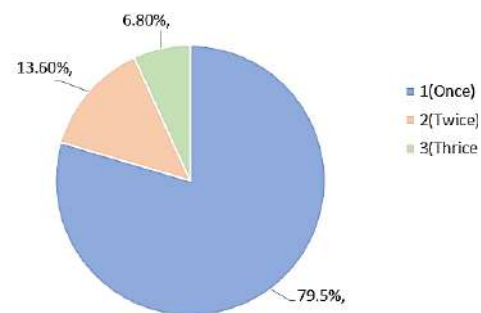


Figure 10: Frequency of change

To understand the multi modal transport the users were asked whether they change their transportation in one trip. 73.3% (44 respondents) users changed their transportation in one trip whereas 26.7% (16 respondents) did not change any transportation in one trip (Refer to fig.9). The users were further asked about the frequency of this change in one trip. 79.5% (35 respondents) changed their transportation 1 time, 13.6% (6 respondents) 2 times, 6.8% (3 respondents) 3 times in one trip (Refer to fig.10).

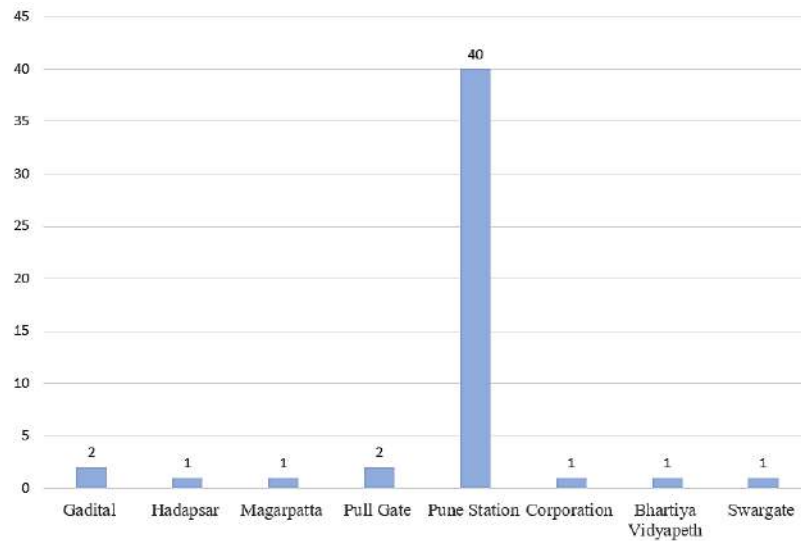


Figure 11: Stop where transportation change takes place

The users were asked where usually do they change their transportation upon which, 84% (40 respondents) change transportation at Pune station, 4% (2 respondents) at Gadital, 4% (2 respondents) at Pullgate, 2% (1 respondent) at Hadapsar, 2% (1 respondent) at Magarpatta, 2% (1 respondent) at Corporation, 2% (1 respondent) at Bhartiya Vidyapeth, and 2% (1 respondent) at Swargate (refer to fig. 11).

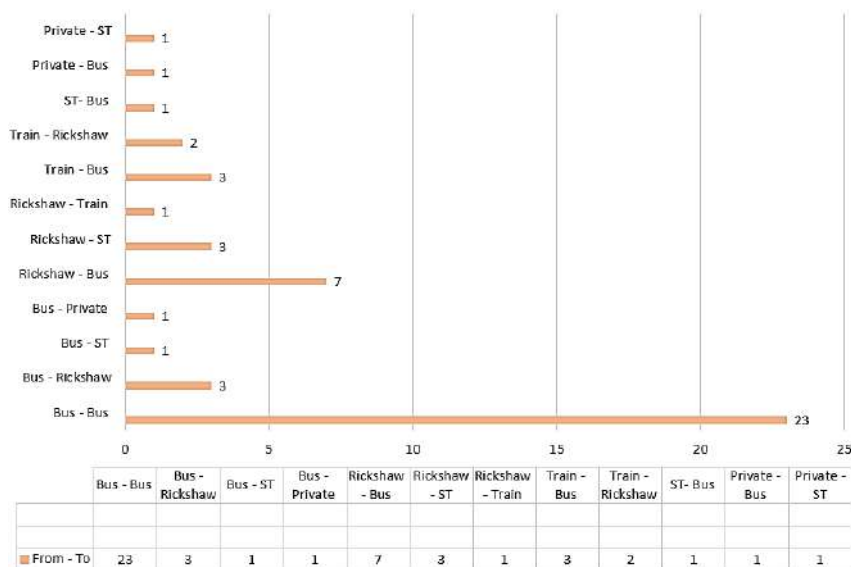


Figure 12: Transportation exchange from – to

As we analysed that, 40 users changed their transportation at Pune Station, to further understand how within that node these exchanges are happening and how the user changes the transportation modes was studied. 23 users changed their mode from bus to bus, 3 users from bus to rickshaw, 1 user from bus to ST, 1 from bus – private, 7 from rickshaw to bus, 3 from rickshaw to ST, 1 from rickshaw to train, 3 from train to bus, 2 from Train to rickshaw, 1 from ST- bus, 1 from Private to bus, and 1 from Private to ST (Refer to fig. 12).

5.4 User Perception

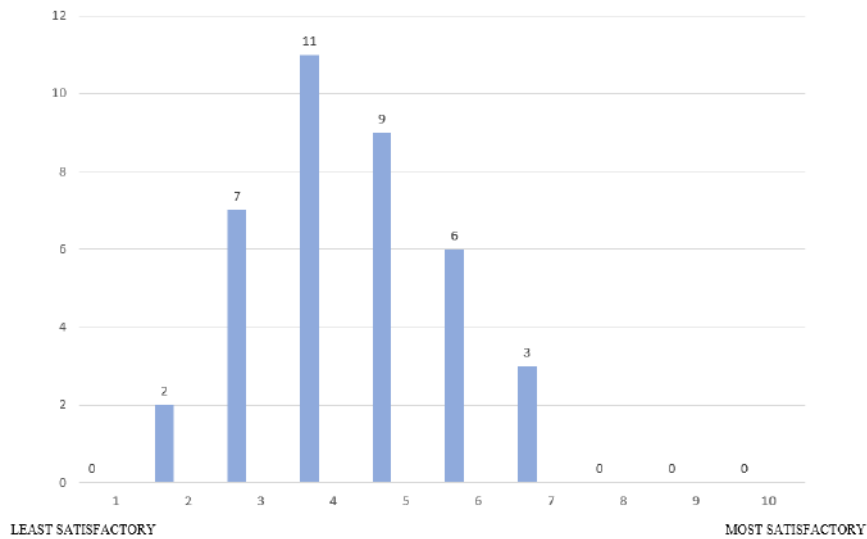


Figure 13: Convenience of changing transport at node

The users were asked to rate their convenience of change of transportation at this node (Pune Station) from 1-10. 1 being the least satisfactory and 10 being the most satisfactory. 2 users rated the convenience as 2, 7 as 3, 11 as 4, 9 as 5, 6 as 6, 3 as 7 (Refer to fig. 13).

The users who had a mixed use of private and public transport were asked to rate the parking facility for their private vehicle from 1-5. 1 being the least satisfactory and 5 being the most satisfactory. 2 users responded with 2 as their rating.

The interview was concluded with a question which asked the users whether a well-planned node at Pune Station will make travelling through public transportation easier with a Yes or No, to which 100% users responded with a Yes.

6. Analysis

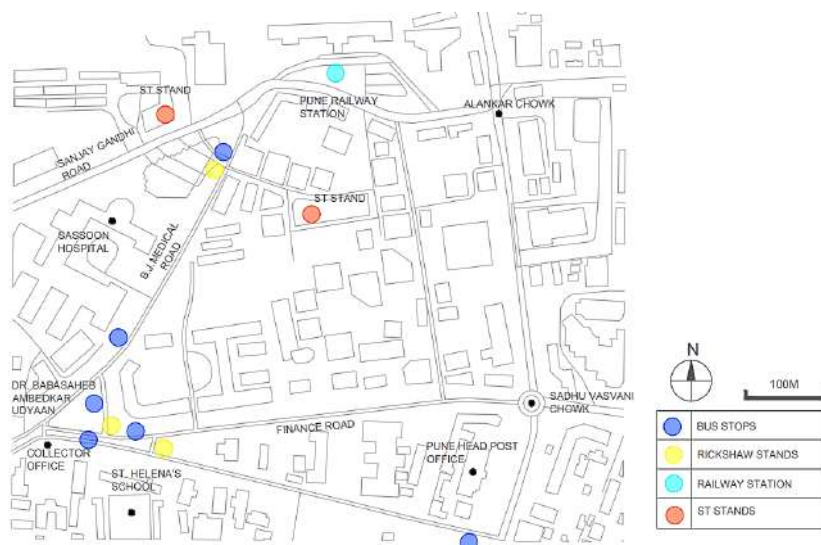


Figure 14: Transport mapping at Pune Station

The senior citizens did not find traveling through buses convenient, one of the reasons contributing towards that could be the crowded buses. The working hours spanned between approximately 10am to 6pm indicating the peaks hours of the day when the traffic at the node is highest. The frequency of changes in transportation were seen less for students and government employees as compared to private sector employees. Most of the users prefer a bus-to-bus transaction this may be due to the low fares of the bus. The users travelling through rickshaw were higher for long distance travellers by train or ST who must have luggage to carry which won't be possible through a bus. The students and other employers travelling through rickshaw mostly shared with others to split the fares. 15 respondents out of 60 did not change their transportation at all in a single trip. Out of these 15, 6 were students. The longest trip length was of 37.3 km starting from Bhekrai Nagar to Hinjewadi Phase 3 to which 3 users travelled to being from the private sector. The convenience of the users was studied with the help of mapping the node of Pune Station. It was observed that the users having transaction from bus to rickshaw rated the convenience as 5/6/7 (1 being least satisfactory and 10 being most satisfactory). The users interchanging from ST to bus or rickshaw rated the convenience as 3/4/5 and the users changing from train to bus or rickshaw rated between 2/3/4. This convenience was studied in relation with the distance between the two modes in the plan and then it was proven to be conclusive. The distance between the train station and the closest bus stop and rickshaw stand is approximately 250m which makes travelling with luggage difficult hence very inconvenient (Refer to fig. 14). The distance between the ST stand and the closest rickshaw stand and bus stop is approximately 140m. The distance between a rickshaw stand and a bus stop is approximately 15-20m which makes it convenient distance wise but the close proximity with the bus stop makes it equally chaotic hence it is rated between 5-7 by the user. The convenience of travelling was taken into consideration the closest bus stop or rickshaw stand which might not be the case every time because, the bus stops and stands are distributed over the area considering the route of the bus or rickshaw so, the distances may vary which might be more inconvenient for the user.

7. Conclusion

15% (9) respondents end their journey at Pune Station and 67% (40) respondents change their transportation at Pune Station. There are 4 major transportations at this node which include, Buses, Rickshaws, Train, ST. Along with the analysis done above it indicates that Pune Station is one of the major nodes of the city. Similarly various other nodes could be identified in Pune by applying similar methodology and considering different routes. It is evident that the transportation system at this node is not nearly as organised and need a solution. In the near future a metro line is expected to pass near Pune Station which will increase the human as well as vehicular traffic at this node. An integrated system linking all the points/modes on this node could be thought of. The average trip length is 18km. The trip length is an indication that there is an urban sprawl. The urban sprawl will have a tremendous impact on PMPML, in the years to come since it would move people over longer distances to meet the needs of commuters.

8. Discussion

The schools, colleges, and government offices have well planned and a strategic location in terms of public transportation as compared to the private sector.

The analysis of the data showed that the students and users working in the government sector changed their transportation less frequently as compared to the ones working the private sector. This

indicates that the IT sectors and business hubs are developed at the outskirts of the city, which is an arising issue of travelling such long distance with the dissatisfaction of having to change one or multiple transportation in one trip.

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Understanding Peri Urban regions and Smart Cities

(Through assessment & dynamics of Urban regeneration in India)

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ABSTRACT:

The rapid urbanisation in India has resulted in un-ubiquitous regional development and multilateral difficulties at diverse levels starting from city to regional levels, which clearly demonstrated the lopsided urban planning and unregulated governance of the urban ecosystem unfavourably. Cities are facing the problems of traffic congestion, reduction of green cover, haphazard peri-urban settlements, an increased traffic, affecting the them and surrounding areas' environment adversely. The present problems will worsen over the coming decades with phenomenal urban population that requires an urgent attention to urban planning with reference to smart cities' development.

The dynamics of peri-urban areas result from many drivers: urban migration, agricultural intensification, industrialization and changing preferences for the location of specific functions, like distribution centres, waste and wastewater treatment infrastructures and similar. The difficulties are compounded by governance complexity – inevitably peri-urban areas tend to extend over multiple government jurisdictions and thus their management is particularly affected by fragmentation of plans and management needing considerable cooperation. In this way peri-urban areas are not simply the intensification of the urban in the rural, but become a spatial category in their own right, deserving of particular attention and distinctive policy approaches.

KEYWORDS:

Sprawl, Dynamism, Fringe, Transformation, Ecological sensitivity, Governance, Expansion

1. INTRODUCTION

Urbanization accompanies economic development. As countries move from being primarily agrarian economies to industrial and service sectors, they also urbanize. Urban areas also contribute a higher share of the **GDP**. While the urban population is currently around **31%** of the total population, it contributes over **60%** of India's GDP. The urban population increased at a higher rate than the rural population first time in 2008. The estimation for 2050 suggests that two-third of the population of the world would be settled in cities or urban settlements. To facilitate the accommodation of these increased populations, cities are expanding. This overspill of cities to their fringe areas and subsequently to the rural areas leads to what is known as **peri urbanization**.

A neo middle class is emerging which has the aspiration of better living standards. The Government of India started the **Smart City mission** in 2015, which will provide ambient, liveable conditions for increasing urban population in the future, suitable environment for future investments, creation of smart jobs and livelihoods, building of green and trustworthy community substructure, provision of

social services to the person who is in last line of accessibility with affordable housing, efficient and consistent energy and most importantly sustainable use of resources for an ecological quality of life.

1.1 Definitions:

1.1.1 Peri-Urban Regions:

Peri-urban areas can be described as *fringe areas* of cities or adjoining rural areas, which are intrinsically linked with the city economy, experience constant transformation, and are characterised by a mix of rural and urban activities. The areas could be imagined as *intermediary* zones overlapping rural and urban jurisdictions (See Figure 1.1) and are inhabited by the native population—who are normally engaged in agro-based activities, livestock rearing, and fishing—as well as by a migrant population who pursue non-farm interests.

Many people wishing to migrate to cities for engaging in economic activity or for pursuing other interests are unable to do so because living costs in cities are high. A more reasonable option for them is to reside in rural areas that are situated just outside city limits, or in the periphery within city limits. There are also instances of population relocation to peripheral areas of cities due to development of planned townships.

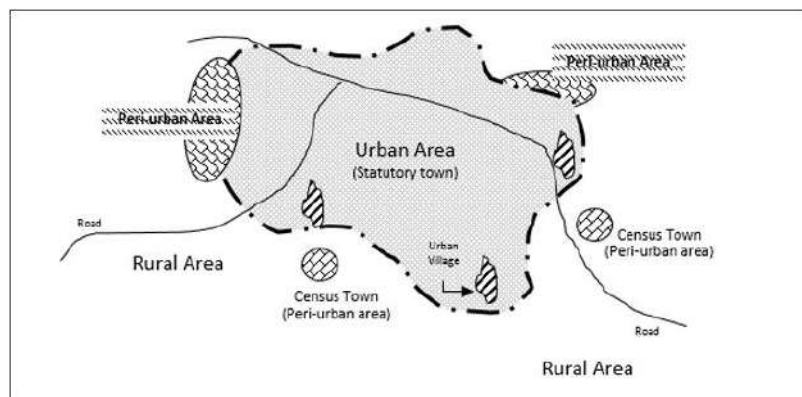


Figure 1.1: A visualisation of urban and peri-urban areas

1.1.2 Smart Cities:

People migrate to cities primarily for employment. To support their happy and comfortable living, people also need good quality housing; cost-effective physical and social infrastructure, such as water, sanitation, electricity, clean air, education, healthcare, security, entertainment, etc. In this context, Smart Cities are those that are able to attract investments for development of infrastructure and other social facilities. Good infrastructure, simple and transparent online processes that make it easy to establish an enterprise and run it efficiently are important features of an investor-friendly city. Without this a city loses attraction as an investment destination. A Smart City investor is considered as someone who helps a city rather than someone who only profits from it.

2. Drivers of Peri-Urbanization:

To develop an understanding of the character of transitional interface, it is pertinent to first study various causes of the development in the peripheries, i.e. the factors which trigger the growth. Multiple correlated and interdepend factors contribute to the development of these areas:

- a) **Physical expansion** of the city limits (urban sprawl): the physical expansion of city to provide for the increasing population leads to the development in periphery.
- b) **Migration** of people from rural to urban: Migration is another driver which contributes to the development. Farmers often migrate from rural settlements to urban areas in search of better job opportunities, however due to increasing living costs in the city, they have no choice but to settle in the less expensive fringe areas.
- c) Establishment of **new economic activities**: Establishing a new industry creates job opportunities in the region attracting people from rural areas.
- d) Development of **city services** in the outskirts: Planning of activities which are generally not provided inside the city, like airports, educational institutions, its hubs etc also become the trigger factors in the growth of the periphery.

Growth	Chennai	Ahmedabad	Chandigarh	Patna	Guwahati
Direction	Southward expansion	Along transport routes	expansion towards Mohali, Panchkula	Growth and reorganization of internal space	More pronounced on the southern side
Drivers of growth	Growing as an IT corridor engulfing several fishing and agricultural villages and hamlets.	Construction along transport routes lucrative for real estate developers. New industrialization along the roads.	Development of information technology park and the Himalayan express-way.	People of the rural poor, migrating to the area and the slum dwellers being resettled from the city.	Construction of institutions, apartments, industries

Table 2.1 Drivers of peri urbanization in Indian Cities

3. So, what are the issues?

Both, *the native population* and *migrant settlers* in peri-urban areas derive various benefits from their proximity to cities. However, the adverse impacts of urbanisation are also visible in peri-urban. Therefore, it may be useful that along with developing India's villages and small/medium towns—which will help in **reducing migration** to megacities/urban agglomerations and ensure a **balanced distribution** of the country's population—immediate efforts must be made to understand and manage the transformation occurring in peri-urban areas.

Enough evidence exists that *an eco-system* is bound to be affected when the carrying capacity is pushed to the limits. This is true for peri-urban areas, too. India's existing peri-urban areas are

undergoing a transformation and are under tremendous *stress* due to pressures created by urbanisation.

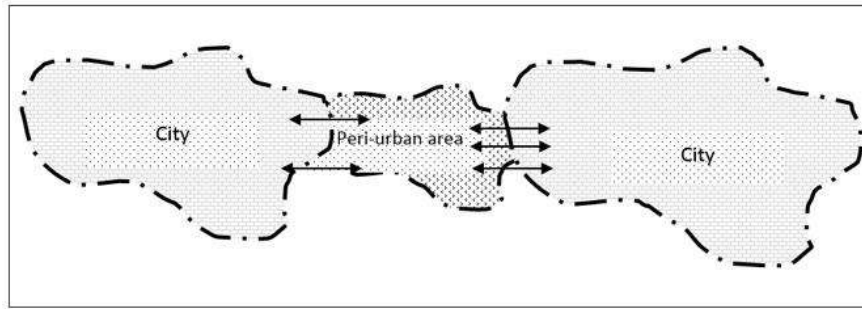


Figure 3.1: A visualisation of migration flow in peri-urban areas

Table 3.1

Issues	Causes
<ul style="list-style-type: none"> Uncontrolled growth Unregulated/haphazard development Abysmal services (water, sanitation) 	<ul style="list-style-type: none"> Absence of statutory development plans, laws, land use maps & land monitoring systems
<ul style="list-style-type: none"> Increase in population density/buildings 	<ul style="list-style-type: none"> Absence of land/building/development controls
<ul style="list-style-type: none"> Unsafe high-rise-built structures 	<ul style="list-style-type: none"> Fragmented & uncoordinated planning
<ul style="list-style-type: none"> Shrinking open spaces Changing land use 	<ul style="list-style-type: none"> Lack of clarity in administrative boundary & areal extent
<ul style="list-style-type: none"> Delays in project implementation 	<ul style="list-style-type: none"> Administrative unpreparedness & inferior management of the area
<ul style="list-style-type: none"> Forced eviction of unauthorised occupants 	<ul style="list-style-type: none"> Prohibition to apply urban byelaws
<ul style="list-style-type: none"> Displacement of native population. Reduced food grain & vegetable produce; rising food grain prices 	<ul style="list-style-type: none"> Unplanned dispersal of industries & other economic activities from city

3.1 Can they be explained further?

3.1.1 Unregulated development

Uncontrolled growth at the periphery of cities is occurring, as seen in the increasing population densities and haphazard development of built structures (residential, commercial, industrial) that fail to meet building safety norms. The local administration agencies are neither vigilant, nor equipped to prevent such violations.

- The National Capital Region (*NCR*) plan for 2021, for example, refers to non-existence of proper legislation, planning and development controls in rural areas close to Delhi, which has led to unauthorised conversion of rural land to urban use, and the growth of unplanned urban/industrial activities.

- In a study of a peri-urban area of Indore city in *Madhya Pradesh*, lack of statutory development plans, development controls and building by-laws, land use maps and institutional monitoring systems is observed.
- Even in the *Mumbai* region in the state of Maharashtra, for which a statutory regional plan is prepared by the Mumbai Metropolitan Region Development Authority (*MMRDA*) to control future development, the existence of *fragmented and uncoordinated planning* practices results in unregulated development in peri-urban areas.

Such deficiencies in planning and governance leave these areas open for the rampant construction of *illegal structures* by individuals and groups. Private *real estate developers* are also able to convince villagers with attractive prices to acquire, gain control and hold agricultural land, and carry out illegal sub-division and disposal when land values increase. There are cases of peri-urban areas being colonised by private builders and public sector agencies that cater only to the interests of influential groups.

3.1.2 Population displacement

The shrinking in size of vacant lands and open spaces due to illegal constructions in peri-urban areas also affects implementation of local and regional infrastructure projects.

- In the National Capital Region, difficulties have been faced in laying down a regional circular road corridor around Delhi because land is occupied by unauthorised buildings. From the time of the announcement of the road project and until its implementation, there have been a series of protests by the population affected by the project. The households were unwilling to be relocated because of the huge investment made by them on constructing their homes. However, since the residents were unauthorised occupants of land, they were eventually evicted.

In many places, due to the growing demand for housing, land has been legally acquired by private developers for building planned townships adjacent to large cities for the *low, middle and high-income* groups. This practice—which is only growing over time—often displaces the native population comprising small farmers and landless labourers, and causes *unemployment* due to changing land uses.

3.1.3 Slum-like conditions

Another negative consequence is the emergence of unauthorised (and therefore unplanned) colonies in the neighbouring areas where *basic services* are abysmal and the quality of life is comparable to that in slums. There is, however, a close relationship between the two areas: residents of the planned colonies look to the neighbouring unplanned colonies for hiring *domestic help* (e.g., cleaners, gardeners, and drivers).

3.1.4 Indiscriminate land use conversion

With regard to changes in land use, it is observed that *agricultural land* is indiscriminately being converted to urban use, resulting in reduced food grain and vegetable production. This affects local and regional *supply of food*. Many cities are solely dependent on the rural food-producing hinterland, and a reduced supply from the neighbourhood implies food being brought from farther distances, and in turn, consumers paying more.

- In the *Hubli-Dharwad* region of south India, other types of changes are being observed. For one, with a growing proportion of the farming community exploring and engaging in urban

activities in view of higher economic returns, weightage is given to cultivation of less labour-intensive crops.

- In **West Bengal** describes the shifts from agriculture to household industry and other sectors, such as construction, trade and transport in some census towns. People who are unable to cope with the changes in their livelihoods end up facing reduced incomes.

3.1.5 Abysmal water, sanitation and environment

The other set of problems pertain to infrastructure and service availability in peri-urban areas. With respect to water, peri-urban areas generally remain uncovered by formal service delivery systems (*pipd and metered supply*). Thus, residents have to make their own arrangements. The practice of collecting water (often from untreated sources) to meet daily requirements is time consuming and affects income as well as health.

The high requirement of water for a variety of purposes within peri-urban areas also reduces the quantities available for the native population, for their *crops, and livestock*. The availability is also affected by the *depletion* of surface water sources, such as rivers and lakes which tend to be *exploited* beyond their replenishing capacity to meet the city's water requirements.

The other important aspect is the *quality* of surface water, on which birds and water species thrive, which act as rainwater reservoirs and utilised by the poor communities. These water sources have become receivers of *untreated* domestic, commercial and industrial liquid and solid *waste*. The vulnerability of the population living in peri-urban environments may be understood from the damage caused to their agricultural lands, food crops and health due to the disposal of harmful industrial effluents in canals from where water is obtained for crop cultivation.

- There are also instances of huge surface water bodies, on which animal species thrive, filled with debris to make way for new constructions. This phenomenon is prominent on the outskirts of **Chennai**. Adequate arrangements for surface water drainage have not been made which causes *waterlogging* during the rainy season. Besides causing harm to the road surface, the waterlogged areas also become breeding grounds for mosquitoes, posing *health hazards* to the population.

Inefficiencies in *solid waste management* are prominent too. In populous cities, the capacities of dumping sites are *exhausted* and the managing agencies are struggling with waste disposal. Institutional *inefficiencies* in waste planning and handling are an important reason for the occurrence of the problem. City governments thus see vacant lands in fringe areas as ideal places for dumping solid waste.

Within peri-urban areas, there are notable irregularities in waste collection and disposal. Thus, deterioration is seen in the environment. The untreated waste dumped on agricultural land, in water bodies, and along roads by the native population/city agencies, reduces soil productivity, contaminates surface and ground water and seriously affects public health.

3.1.6 Poor mobility and connectivity

Mobility within peri-urban areas and proper *connectivity* of the peri-urban areas with the city and surrounding settlements by suitable *transport networks* and facilities are the other matters of concern. Generally, the surface of local roads and streets is in bad condition, proper *pavements* for walking and vacant spaces for motor vehicle *parking* are unavailable, and, due to their peripheral

location, the areas are not served adequately by convenient, leading to the growth of private motor vehicles, in turn causing *traffic* congestion and air *pollution*.

- In peri-urban areas situated between two adjoining cities, namely Delhi and Gurugram, proper road corridors have not been created for connecting one city with the other at various points. Thus, thousands of motorists going from one city to the other every day for work or other reasons pass through the narrow and poorly maintained corridors (rural roads) available in peri-urban areas. The high density of motor vehicles, compounded by violations of traffic rules, result in heavy traffic and long commutes.

4. So, is Smart city a better solution?

Current cities follow complex systems that are characterized by massive numbers of interconnected citizens, businesses, different modes of transport, communication networks, services, and utilities. Population growth and increased urbanization raise a variety of technical, social, economic, and organizational problems that tend to jeopardize the economic and environmental sustainability of cities. In this context, a debate has emerged on the way new technology-based solutions, as well as new approaches to urban planning and living, can assure future viability and prosperity in metropolitan areas.

4.1 Need for the Smart City:

Indian urbanisation needs a total retrofitting to accommodate growing urban population which is going to be half of Indian population by the next two decades. To accommodate the rapid urbanisation and a range of the socio-economic and technological developments across the globe, the Government and policymakers decided to implement smart city mission

4.2 Scope of Smart City:

While launching Digital India, a plan to build 100 smart cities across the country. Cities in the past were built on riverbanks. They are now built along highways but in the future, they will be built based on availability of optical fibre networks and next-generation infrastructure.

	Domain	Objective
Growth Needs	Energy grids	Automated grids that employ Information and Communication Technology (ICT) to deliver energy and enable information exchange about consumption between providers and users, with the aim of reducing costs and increasing reliability and transparency of energy supply systems.
	Public lighting, natural resources, and water management	renewable resources, such as heat, solar, cooling, water, and wind power.

	Waste management	Applying innovations in order to effectively manage the waste generated by people, businesses, and city services. It includes waste collection, disposal, recycling, and recovery.
	Environment	Using technology to protect and better manage environmental resources and related infrastructure, with the ultimate goal of increasing sustainability. It includes pollution control.
	Transport, mobility, and logistics	Optimizing logistics and transportation in urban areas by taking into account traffic conditions and energy consumption. Providing users with dynamic and multi-modal information for traffic and transport efficiency. Assuring sustainable public transportation by means of environmentally friendly fuels and innovative propulsion systems.
	Office and residential buildings	Adopting sustainable building technologies to create living and working environments with reduced resources. Adapting or retrofitting existing structures to gain energy and water efficiency.
	Healthcare	Using ICT and remote assistance to prevent and diagnose diseases and deliver the healthcare service. Providing all citizens with access to an efficient healthcare system characterized by adequate facilities and services.
	Public security	Helping public organizations to protect citizens' integrity and their goods. It includes the use of ICTs to feed real-time information to fire and police departments
Deficiency Needs	Education and culture	Capitalizing system education policy, creating more opportunities for students and teachers using ICT tools. Promoting cultural events and motivating people participation. Managing entertainment, tourism, and hospitality
	Social inclusion and welfare	Making tools available to reduce barriers in social learning and participation, improving the quality of life, especially for the elder and disabled. Implementing social policies to attract and retain talented people
	Public administration and (e-) government	Promoting digitized public administration, e-ballots, and ICT-based transparency of government activities in order to enhance citizens empowerment and involvement in public management.
	Economy	Facilitating innovation, entrepreneurship, and integrating the city in national and global markets

Table 4.2: Classification of Smart City components**5. Challenges before Indian Smart Cities**

5.1 Migration for jobs: Migration from one area to another in search of improved livelihoods is a key feature of human history. While some regions and sectors fall behind in their capacity to support populations, others move ahead and people migrate to access these emerging opportunities. Industrialization widens the gap between rural and urban areas, inducing a shift of the workforce towards industrializing areas. Moreover, numerous studies show that the process of migration is influenced by social, cultural, and economic factors and outcomes can be vastly different for men and women, for different groups, and different locations.

5.2 Education: Rural areas, by and large, lack educational facilities, especially those of higher education and rural people have to migrate to the urban centres for this purpose. Many of them settle down in the cities for earning a livelihood after completing their education.

5.3 Lack of security: Political disturbances and interethnic conflicts drive people away from their homes. A large number of people have migrated out of Jammu and Kashmir and Assam during the last few years due to disturbed conditions there. People also migrate on a short-term basis in search of better opportunities for recreation, healthcare facilities, and legal advices or for availing service that the nearby towns provide.

5.4 Transport: City efficiency largely depends upon the effectiveness of its transport systems, that is, efficacy with which people and goods are moved throughout the city. Poor transport systems stifle economic growth and development, and the net effect may be a loss of competitiveness in both domestic as well as international markets. Although Indian cities have lower vehicle ownership rate, number of vehicles per capita, than their counterparts in developed countries, they suffer from worse congestion, delay, pollution, and accidents than cities in the industrialized world.

5.5 Energy management: In the past few years, the level of energy waste in India has been on the rise, underscoring the need for the government and other stakeholders to address issues of sustainable development. India has the world's fourth largest electricity installed capacity, according to the Ministry of Urban Development's 2014 Concept Note⁴ on Smart City. Yet, it continues to be a country with scarce electricity distribution. Here, smart grids can be a good way of bringing in transformative operations. There are many challenges:

- The old traditional system lacks good financial planning, resulting in losses due to poor revenue collection methods.
- The system is also ageing with poorly maintained infrastructure, such as transmission lines, among others.

5.6 Information and communication technology: A common infrastructure pool allows the creation of a truly interconnected system with seamless communication between services. The sharing and unifying of the information infrastructure, or even the sharing of meaningful information/data such that it can improve efficiency and the quality of life of its citizens is an opportunity that will be recommended. However, there are many challenges:

- All resources and information generated by the city from different sources, systems, and services are distributed in different departments, regions, and their respective information systems.
- Technology challenges; the existing status quo in how cities are run; and technology is not well understood across city sectors and by its administrators
- Among the main barriers to adopting such solutions is the complexity of how cities are operated, financed, regulated, and planned.
- Rapid urbanization adds pressure to the resource base and increases demand for energy, water, and sanitation, as well as for public services, education, and healthcare. Consequently, social, economic, and environmental issues have become closely interrelated.

6. What is Government's role in all this?

6.1 Policies & Regulation: In 2005, Government of India (GoI) decided to make a major *intervention* to bring about *improvements* in the urban scenario by launching the reforms driven, fast, planned development of cities through **JnNURM** with a huge grant provision of a little over **660 billion**.

6.2 Funding Pattern: The Smart City Mission will be operated as a *Centrally Sponsored* Scheme and the Central government proposes to give financial support to the Mission to the extent of **48,000 crores** over five years, that is, on an average 100 crore per city per year. An equal amount, on a *matching basis*, will have to be contributed by the State; therefore, nearly Rupees1 lakh crore of Government funds will be available for Smart City development.

The project cost of each Smart City proposal will *vary* depending upon the level of ambition, model, capacity to execute, and repay. A large part of the financing for smart cities will have to come from the private sector with the States/Cities and Central government only supplementing that effort.

6.3 Nature and extent of Central government support

The Central government's support will be in three forms:

- **Financial support:** huge investments will be needed. Therefore, innovative methods of raising revenues will have to be developed by the States and Cities. These efforts will be supplemented by the Central government through the Ministry of Urban Development and other Ministries responsible for different sectors, such as health, education, power, transport, IT, communications, etc., by way of allocations specifically for the development of Smart City.
- **Policy support and legal backings:** It is recognized that urban development is a State Subject under the Constitution of India. Yet, the Central government can play an important supporting role in facilitating appropriate policies that provide a framework for urbanization. While we have a National Urban Transport Policy, we do not have a national urban policy. It would be appropriate for the Urban Transport Policy to also fall within the *framework* on a National Urbanization Policy.
- **Capacity building:** Developing 100 Smart City across the country will need a large number of professionally. *Trained manpower* and several decision support systems to be in place. Thus, there is a need for a large capacity building programme that encompasses training, education, contextual research, knowledge exchange, and a rich database.

- **Approval process:** The States would be required to submit proposals for approval of the respective satellite cities, cities of tourist and religious importance, as well as cities in the 0.2–1.0 million population range.

6.4 Government initiatives

Smart Transport	<ul style="list-style-type: none"> ▪ Ministry of Urban Development plans to invest more than USD 20 billion on the metro rail projects in the coming years. ▪ India's first monorail project at Mumbai will cost around USD 500 million, of which USD 183 million has been spent on phase I.
Smart Information and Communication	<ul style="list-style-type: none"> ▪ Broadband connections to 175 million users by 2017. ▪ Under the flagship 'Safe City' project, the Union Ministry proposes USD 333 million to make seven big cities (Delhi, Mumbai, Kolkata, Chennai, Ahmedabad, Bengaluru, and Hyderabad) to focus on technological advancement rather than manpower.
Smart Buildings	<ul style="list-style-type: none"> ▪ The Intelligent Building Management Systems market is around USD 621 million and is expected to reach USD 1,891 million by 2016. ▪ Smart buildings will save up to 30% of water usage, 40% of energy usage and reduction of building maintenance costs by 10 to 30%
Smart Governance	<ul style="list-style-type: none"> ▪ USD 83 million allocated for Digital India Initiative. ▪ Plans to develop at least two smart cities in each of India's 29 states. ▪ Delhi–Mumbai Industrial Corridor Development Corporation Limited (DMICDC) plans seven smart cities along the 1,500 km industrial corridor across six states with total investment of USD 100 billion.
Smart Energy	<ul style="list-style-type: none"> ▪ Establish smart grid test bed and smart grid knowledge centre. ▪ Implementation of eight smart grid pilot projects in India with investment of USD 10 million. ▪ Addition of 88,000 MW of power generation capacity in the 12th Five-Year Plan (2012–17). ▪ The Power Grid Corporation of India Limited has planned to invest USD 26 billion in the next five years. ▪ Installation of 130 million smart meters by 2021.
Smart Environment	<ul style="list-style-type: none"> ▪ Ministry of New and Renewable Energy has plans to add capacity of 30,000 MW in the 12th Five-Year Plan. ▪ The Indian Ministry of Water Resources plans to invest USD 50 billion in the water sector in the coming years. ▪ The Yamuna Action Plan Phase III project for Delhi is approved at an estimated cost of USD 276 million.

7. Conclusion:

It is evident that both the core city and the urban centre witness growth at high rates. Since the land prices in the peripheries are very low, peri urban areas attract real estate; development becomes lucrative on these areas, contributing to the growth of the peri urban areas. Also, development of transport networks, IT hubs, industries etc. become the drivers of growth, which lead to enhancing the dynamic nature of the peri urban growth. These transforming areas present both opportunities and challenges, which are of significance in order to plan for these critical areas. These challenges include - natural resource depletion, environment, social and ecological challenge. However, careful analysis and case studies show that these highly dynamic areas have potential for a holistic planned intervention to not only decongest the urban core but also create a more symbiotic rural urban linkage. Establishment of context specific, evidence-based framework for development and setting up

of green byelaws for these areas in the initial stages of transformations can lead to not just abating degradation but also can prove to be beneficial in regenerating the balance of the ecosystem of urban areas.

Smart Cities Mission in India is an urban regeneration retrofitting programme with a strong focus on physical and cyber infrastructure. In terms of its planning, the smart city mission is an area-based planning with strong forward and backward linkages with creation and return of investment and finances, inspiring Indian cities to move towards market-based funding so that it can create healthy competition for growth and development of smart cities

All the major sectors under the SCM namely adequate water supply, assured electricity supply, sanitation, including solid waste management, efficient urban mobility and public transport, affordable housing, especially for the poor, robust IT connectivity and digitalisation, good governance, especially e-governance and citizen participation, sustainable environment, safety and security of citizens, particularly women, children and the elderly, and health and education needs an overhaul if we expect commitment for building sustainable cities that will last centuries.

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Note: Collaborations are in the process and will be received in short period.

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