Research Journal Vol. 20, No. (2), 2024 ISSN 0974 - 0317 Research Journal

Research Journal

Half Yearly Double Blind Peer Reviewed Journal of Science, Home science & Home Science Technology

RESEARCH DEVELOPMENT CELL

WOMEN'S EDUCATION SOCIETY'S

LADY AMRITBAI DAGA COLLEGE FOR WOMEN OF ARTS, COMMERCE & SCIENCE AND SMT. RATNIDEVI PUROHIT COLLEGE OF HOME SCIENCE & HOME SCIENCE TECHNOLOGY

NAAC - Re-accredited 'A' Grade

Estd. 1932

Research Journal

Half Yearly Double Blind Peer Reviewed Journal of Science, Home science & Home Science Technology

Co-ordinator
Dr. Pooja Pathak

Convenor
Dr. Rujuta Bapat

Editor-in-Chief
Dr. Surashmie Kaalmegh

Co-Editor
Dr. Charuta Gajbhiye

Editorial Board

Dr. Sumita Sapre
Dr. Nandita Sapra
Dr. Shraddha Patelia
Dr. Nibha Bajpai

Research Journal Vol. 20, No. (2), 2024 ISSN 0974 - 0317 Research Journal

Research Journal

Half Yearly Double Blind Peer Reviewed Journal of Science, Home science & Home Science Technology

RESEARCH DEVELOPMENT CELL

WOMEN'S EDUCATION SOCIETY'S

LADY AMRITBAI DAGA COLLEGE FOR WOMEN OF ARTS, COMMERCE & SCIENCE AND SMT. RATNIDEVI PUROHIT COLLEGE OF HOME SCIENCE & HOME SCIENCE TECHNOLOGY

NAAC - Re-accredited 'A' Grade

Estd. 1932

Research Journal

Half Yearly Double Blind Peer Reviewed Journal of Science,
Home science & Home Science Technology

Editorial Office

Research Development Cenber
L.A.D. & Smt. R. P. College for Women,
Shankarnagar, Nagpur - 440 010.
Phone: 0712-2247192, 2246623
Email: principal@ladcollege.ac.in
URL : ladcollege.ac.in/research/

Publishers

Swaprakashan Publication Cell
L.A.D. and Smt. R. P. College for Women, Nagpur.

Printer

Shyam Brothers
S. T. Stand Road, Ganeshpeth, Nagpur.

© Research Journal Vol. 20, No.(2), 2024. All rights reserved. No part of this publication may be reproduced in any form or by any means or used by any information storage and retrieval system without written permission from the copyright owner.

Opinions expressed in the articles, research papers are those of contributors and do not necessarily reflect the views of the publisher. The publisher is not responsible (as a matter of product liability, negligence or otherwise) for any consequences resulting from any information contained therein.

Subscription Rates

Institutional: Rs. 2000/- (per annum two issues)
Individual: Rs. 1000/-

EDITORIAL

When evaluating contemporary research, the true measure of a scholarly contribution lies not merely in its thematic scope, but in the methodological rigor with which it is executed. Across disciplines— ranging from ecological conservation and material to psychological well-being and socio-economic development. —the reliability of academic literature depends entirely on the transparency and robustness of its underlying frameworks. Rather than grouping investigations by isolated subjects, this volume is best analysed through its methodological approaches: how researchers collect data, structure experiments, deploy psychometric instruments, and manage material systems.

Modern industry faces an urgent mandate to rethink waste and energy through solutions like biomass combustion, fly ash silica extraction, and commercial food waste management. These technical interventions are paired with lifecycle management—such as evaluating plastic waste recycling through mechanical, chemical, and biological lenses—while extending to grassroots community empowerment via household kitchen gardens and women's self-help groups. The arc shifts inward to formulation chemistry and daily material culture, where researchers rigorously test natural cosmeceuticals like activated charcoal, tea tree oil, and marine derivatives. These laboratory investigations demand standardized extraction protocols and unyielding safety evaluations before commercial scaling, intersecting directly with market-driven consumer choices and energy-efficient workplace standards like LED adoption.

Ultimately, both material innovation and environmental systems exist to serve human societies, bringing our conceptual arc to its logical destination: psychosocial dynamics, gender equity, and regional development. The structural integrity of any society is tested within its occupational and institutional environments, where empirical studies in this volume expose the pressing realities of gender dynamics, stress factors, and remuneration disparities within the service and hospitality sectors. Moving from the workplace to the inner mind, investigations into adolescent emotional maturity, self-concept, and developmental variables remind us of the critical need for standardized psychometric instruments and precise scale-scoring interpretations. Finally, this human-centric arc expands outward to regional geographies, where evaluations of tourism and trekking initiatives capture the delicate equilibrium required to foster local economic growth without sacrificing the integrity of fragile ecosystems.

The research contributions assembled in this volume trace an intellectual journey, operating as interconnected chapters in a larger narrative about how modern scholarship confronts real-world friction. By examining the trajectory from ecological resource management to consumer technology, and finally to human well-being, this collection maps a holistic blueprint for sustainable development. Viewed as a single, cohesive tapestry, the research in this volume transcends isolated academic exercises. It presents a unified vision of modern scholarship—one where ecological stewardship, technological precision, and human resilience are inextricably linked.

Dr. Surashmie Kalmegh
Editor

Advisory Board

Dr. U. Chakradeo	Vice Chancellor SNDT University, Mumbai
Dr. S. Vali	Former Head and Professor Dept. of Home Science, RTM Nagpur University, Nagpur
Dr. Ismail Kellelu	Ex. Director P. G. Dept. of Travel & Tourism, RTM Nagpur University, Nagpur
Dr. A. M. Ittadwar	Principal Gurunanak College of Pharmacy, Nari, Nagpur
Dr. S. R. Marathe	Practicing Architect Ramdaspeth, Nagpur
Dr. A. S. Muktibodh	Head Department of Mathematics Mohota Science College, Nagpur
Dr. C. V. Dhuley	Ex. Head Department of Electronics Dharampeth M. P. Deo Memorial Science College, Nagpur
Dr. N. Mrunal	Ex. Head PGTD Physiology RTM Nagpur University, Nagpur
Dr. Hemant Pande	Associate Professor & Head Department of Chemistry Chairman DSP Programme Initiative for Research and Innovations (Sc.) Hislop College, Nagpur
Mrs. S. Kawale	Associate Professor and Head Department of Textile and Clothing Yashwant Mahavidyalaya, Wardha

Research Journal

Vol. **20**, No. **(2) 2024**

Contents Page No.

1. Urban Rejuvenation Planning, as a Framework for Arresting Inner-City Decline: A Proposed Urban Rejuvenation Authority for Indian Cities..... 1
Dr. Anuradha Sachdeva, Dr. Ujwala Chakradeo

2. Impact of Extension Education on Sustainable Rural Development..... 16
Dr. Tehseen R. Choudhary

3. Emotional Stability and Resilience of Adolescents: A Correlational Study..... 21
Ms. Anagha Yarnal and Dr Shraddha Thacker

4. A Review on Emerging Paradigms in Electric Vehicle Charging Monitoring and Integrated Fire Protection System..... 29
U. Bhandekar, M. Lute, A. Bashir, N. Nellore, N. Saklani

5. Causes and Consequences of Workplace Stress among Teachers..... 38
Ms. Rashmi Kochey

6. Aggressive Behavior in Adolescents: Role of Gender and Board of Education..... 43
Ms. Reema Siddhu

7. A Study Of Life Satisfaction And General Well-being Among Women..... 48
Apeksha V. Dhote and Dr. Shraddha Thacker

8. Sustainable Vernacular Building Traditions of Vidarbha: A Study Across Selected Agro-Climatic Zones..... 59
Dr. Seema M. Burele

9. Bio-Climatic Building Design Strategies for Nagpur Region: A Mahoney Table-Based Approach..... 70
Sneha Bodhankar, Neeta Lambe

Urban Rejuvenation Planning, as a Framework for Arresting Inner-City Decline: A Proposed Urban Rejuvenation Authority for Indian Cities

Dr. Anuradha Sachdeva[1], Dr. Ujwala Chakradeo[2]

Smt. Manoramabai Mundle College of Architecture, Nagpur, India
*anuradhaanu2@gmail.com

Abstract

Indian cities are witnessing the deterioration of their historic inner-city areas in spite of the existence of statutory framework i.e. Development Plans (DPs) and Development Control Regulations (DCRs). Development Plans provide a comprehensive framework for urban growth, but they often fail to address the challenges of declining inner-city areas due to inadequate monitoring, a lack of periodic assessment, limited stakeholder participation, and the absence of implementation review mechanisms. This research investigates deficiencies in the existing legal planning framework, using Nagpur as a case study, and proposes an Urban Rejuvenation Plan (URP) administered by a dedicated Urban Rejuvenation Authority (URA). The study engages document analysis, qualitative stakeholder surveys, comparative evaluation of planning regulations, and international case studies from Singapore, Hong Kong, Oregon and Sao Paulo, and few efforts taken in India from cities like Mumbai, and Ahmedabad. Findings reveal significant gaps in pre-implementation assessment, post-implementation review, and institutional coordination. The proposed framework introduces a cyclical rejuvenation process comprising of Situation Analysis, Assessment, and Change Management, supported by these three strategies—Reactionary, Reformatory, and Revolutionary. The paper argues that a statutory Urban Rejuvenation Authority can provide an effective governance mechanism for rejuvenating the deteriorating urban cores and ensuring sustainable urban development.

Key words : Inner cities, Urban Growth, urban Rejuvenation, Decline, Institutional framework

1. Introduction :

People migrate to urban areas for diverse opportunities, ranging from education to economic advancement. However, urban population growth has historically been uneven. Globally, approximately 90% of the population resided in rural regions prior to 1800 CE. In the United States, for instance, the rural population stood at 94% in 1800 before dropping significantly to 60% by 1900 CE.". (Junhua, 2022)

The few side-effects of urbanisation, such as decreasing urban population density, loss of agricultural land, and a decline in land use efficiency. However, there is little systematic analysis of these trends available in any part of the world; especially with regard to small and medium-sized cities. Another hurdle in understanding is the lack of knowledge with regard to the changing urban land cover of cities of different population sizes. This land efficiency is not very significant in these fast-expanding cities. Here urban land expansion outpaces the Government capacity of these cities and also affects the livelihood of those areas.

The Indian historic cities, originated because of locational, political, religious and defense factors which had planned origins, later occupied or controlled by the Britishers clearly evident an influence of the leftover area with haphazard and organic growth. The inner city plays an important role in the growth and expansion of cities. These inner cities add up rings and then turn into the full-grown city. This leads to the growth and expansion of the city which results in urban sprawl (Peiser, 1989). The inner cities became congested, resulting in the movement of the indigenous population to the suburbs, and the informal class working population taking over the congested central areas. Inner-city decline is a multidimensional process involving the deterioration of the physical, social, economic, environmental and infrastructural fabric of

established urban cores (Andrews, 2018). In the Indian context, inner-city decline is manifested through congestion, incompatible and non-conforming land uses, increasing commercialisation, building violations, inadequate parking, encroachment, deteriorating housing and heritage structures, narrow roads, insufficient open spaces, and inadequate social and physical infrastructure.

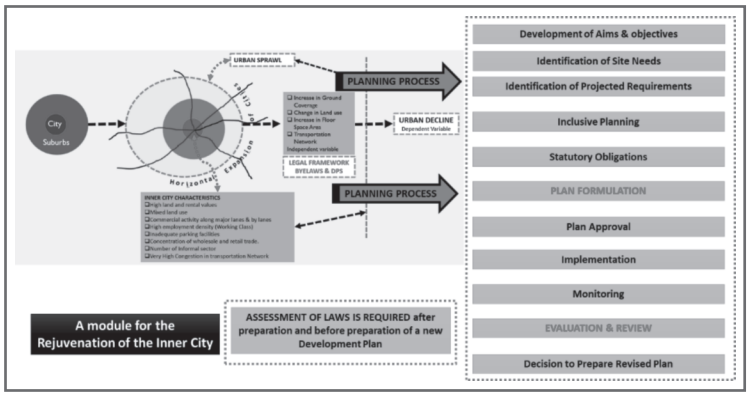


Figure 1: Conceptual framework of research ((Source: Author)

RESEARCH METHODOLOGY

The research has adopted a qualitative and a quantitative method to examine the role of existing legal framework mainly the Development plan and DCRs in resulting is the decline of inner city and propose a legal framework to rejuvenate these inner cities.

Stage I Issue Identification

The study had initiated with the identification of the problem which was leading to the deterioration of the inner-city areas. The study had focused on the limitations which were present in the preparation, pre implementation and post implementation of the existing framework.

Stage II Literature Review

Stage III Primary Survey

A primary survey was done in the inner city of Nagpur to get the ground realities and understand the decline in the area due to the violations in the legal framework.

Qualitative Survey

A detailed literature review and a qualitative survey of stakeholders involved in the planning and development process, including: Town planners, Architects, Government officials, Legal experts, Urban development professionals and citizens were conducted. The survey aimed to validate the inferences drawn from the literature review and the ground realities by understanding the perceptions of experts regarding the effectiveness of Development Plans, Development Control Regulations, implementation practices, and mechanisms for urban renewal.

Stage IV: Analysis of quantitative and Qualitative Survey:

The findings from the primary study and stakeholder survey were co related to identify the recurring issues and deficiencies within the planning system. The analysis was shown in the form of quantitative violations on the selected study area and was zoned in three zones to understand the level of violations and more specifically the degree of problem in the site.

Stage V: Case Examples to identify the probable solution

A detailed literature review on urban renewal, urban regeneration, and redevelopment authorities was commenced. International case studies including Hong Kong, Singapore, Oregon, and Sao Paulo, along with Indian examples such as Mumbai and Ahmedabad, were examined to identify best practices, institutional structures, and policy interventions which can be applicable to Indian cities. Based on these studies an urban rejuvenation plan was proposed under the jurisdiction of Urban Rejuvenation Authority which was unlike conventional Development Plans. The proposed framework incorporated a cyclical review mechanism. Periodic assessment, post-implementation monitoring, and institutional coordination are integrated into the rejuvenation process to ensure continuous adaptation to changing urban conditions and long-term sustainability.

Stage VI Proposal of an Urban Rejuvenation Plan under the Urban Rejuvenation Authority

The overall methodology thus combines legal analysis, spatial assessment, stakeholder consultation, and comparative case study evaluation to formulate a comprehensive Urban Rejuvenation Framework aimed at addressing inner-city decline.

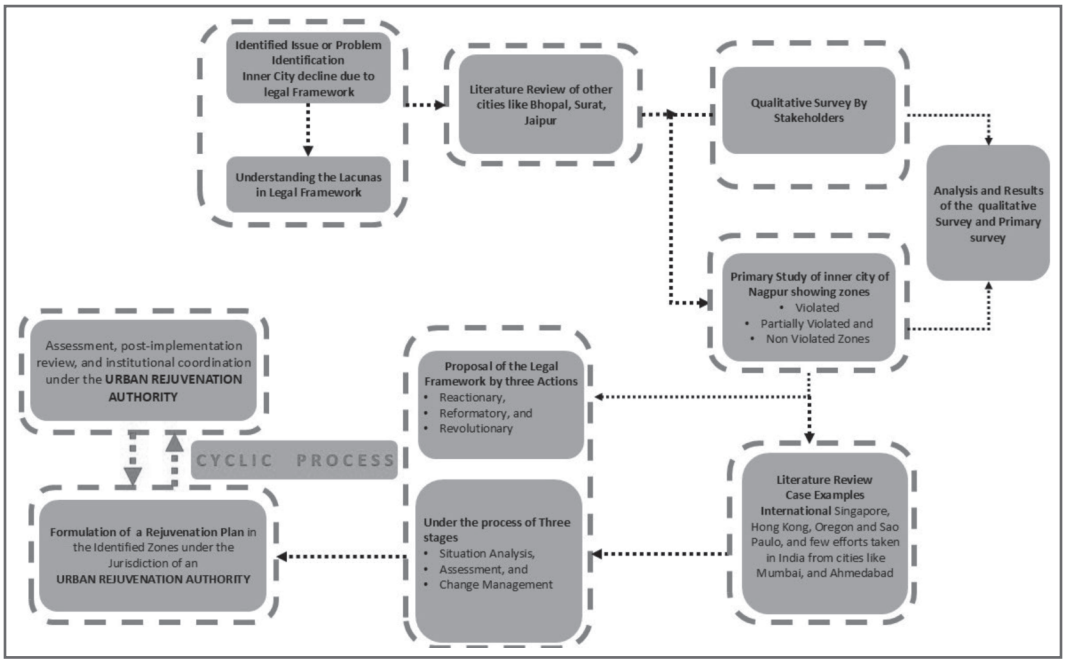


Figure 2: Methodology (Source: Author)

LITERATURE REVIEW

The literature on inner-city development indicates that the urban inner city is a dynamic: spatial, economic and social entity whose transformation is associated with various processes of urban growth, decentralisation and suburban expansion (Vicino, 2007). Theories of urban structure, Burgess's concentric zone model, explain about central areas evolve through processes of concentration, succession and decentralisation, while the other studies focus on automobile-oriented growth and

polycentric development as important forces restructuring the traditional urban core (Burgess, 2008). Research on inner cities further establishes that these areas are highly populated with high employment densities, mixed land uses, strong commercial areas, historical significance and huge economic potential (Bourne, 1978) (Glaeser, 2019) (Faetanini, 2010). However, suburbanisation, urban sprawl, decentralisation of employment and changes in economic activity have contributed to depopulation, physical deterioration and socio-economic decline in many inner-city areas (Peiser, 1989) (Pierson, 2000) (Shaw, 2015).

Studies of Indian cities like Bhopal, Jaipur, Surat demonstrate that these processes are strengthened by congestion, incompatible land uses, inadequate infrastructure, encroachment, deteriorating building stock, insufficient parking, high residential densities and increasing commercialization (Bharathi, 2003) (Salari M, 2017). In the Indian context, the problem is more complicated due to the historical evolution of cities, particularly in colonial spatial structures and their subsequent organic transformation of inner cities (Chattopadhyay, 2000) (Bissel, 2011). Existing literature also indicates that urban decline cannot be understood only as a physical or socio-economic phenomenon, it is significantly influenced by the effectiveness of planning and regulatory mechanisms. Development Plans and Development Control Regulations govern land use, floor space index, ground coverage and density, yet inadequate monitoring, weak documentation, and insufficient post-implementation review can result in persistent deviations and deterioration of inner-city areas (Niroop Abbu, 2015). Studies on urban renewal and regeneration emphasise that interventions need to address not only physical infrastructure but also economic vitality, social inclusion, land assembly and institutional capacity. Land readjustment, participatory planning and redevelopment mechanisms have therefore emerged as potential approaches for managing complex inner-city transformation (Shaw, 2015). The literature further reveals a significant gap and substantial research exists on inner-city decline, urban regeneration and planning regulations, limited attention has been given to examining the direct relationship between violations of statutory planning regulations, the Development Plan process, and the progressive deterioration of Indian inner cities, particularly through an integrated spatial and institutional framework. This gap provides the basis for investigating the role of the existing legal framework in inner-city decline and developing an appropriate framework for urban rejuvenation.

PRIMARY SURVEY OF MAHAL AREA, NAGPUR

The study area is a part of the inner city. The site was chosen between the four Darwazas of the fortified old area, on the western side has Jumma Talab and the Jumma Darwaza, northern side Chitnavis Park, southern side Bhosale Wada, and on the eastern side the Gol Bazaar. The area of the selected site is approximately 10.9 hectare (ha) and is overpopulated with a density of over 1,300 – 1500 pph.

A primary survey was conducted to understand the existing situation in the study area. The parameters identified were Land use, Ground coverage, Height of Buildings, Floor Space Area. The floor space area was analysed in terms of land use to provide a clear picture of the changes which took place in both the floor space area and the land use area.

As per the methodology adopted, the data on all four parameters was also surveyed for the period 2004 – 2005 (Secondary Data) and this data was converted into graphical data by plotting the data from Land use, Ground coverage, Floor Space Area, and Height of Buildings. The comparison between two periods i.e., 2004- 2005 and 2020-2021 was carried out with the applicable Legal Framework i.e., DP 2000 and DCRs (Development Plan of Nagpur, 2000) (City

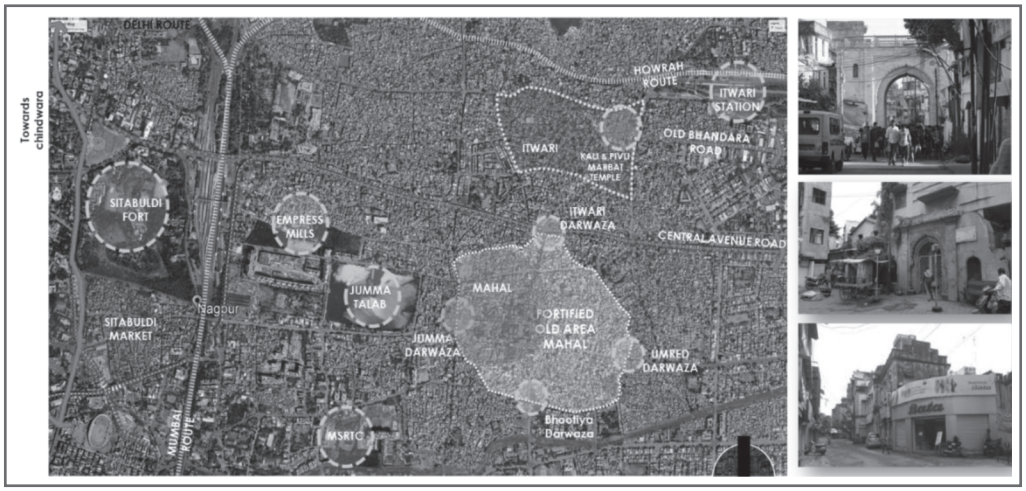


Figure 3: Inner city of Mahal Area and pictographic presentation of the area (Source: Author)



Figure 4: Showing Building use and building heights of inner city (Source: Author)



Figure 5: Commercialisation of the inner city i.e. Mahal area (Source: Author)

Development Plan for Nagpur, 2041, 2015) . The gap was identified is discussed in the further section in the form of Observations, Results and Discussions. The Data was then updated on drawings & various zones were overlayed on the drawings.



Figure 6: Images showing Commercial areas, Narrow lanes, and height of buildings (Source: Author)

The overlay maps and the observations clearly show the changes in the areas being converted from residential and mixed use to commercial areas by adding buildings and also adding floor space which is not permissible in the area. This clearly points towards the violations with respect to land use, floor space area, Ground Coverage and the heights of the buildings observed in the study area.

The changes mapped in layers were then correlated with DCRs, each building was marked as violated or non-violated under the following categories. The zones of three types were established:

1. Violated Zones
2. Partially Violated Zones
3. Non-Violated Zone

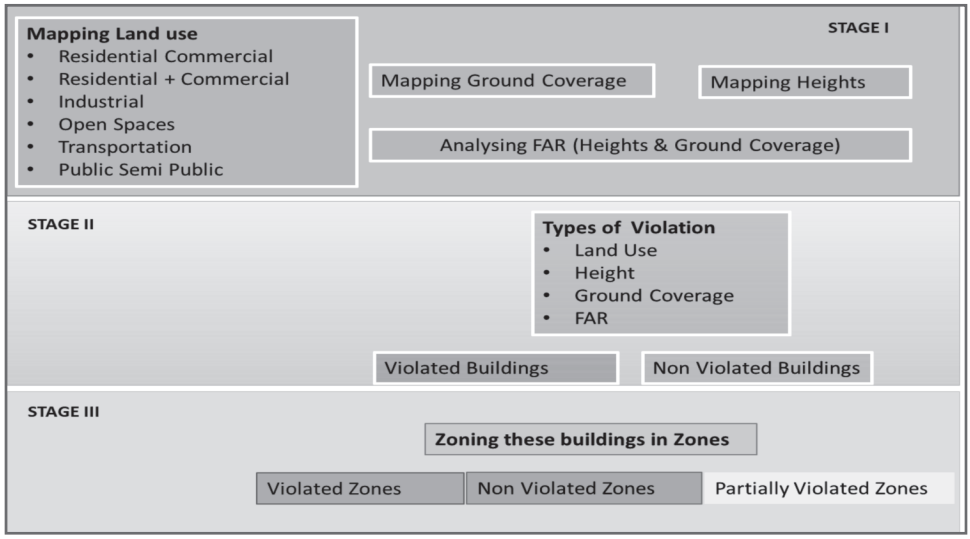


Figure 7: Methodology to Assess the Zones in inner city area

The three zones were demarcated on the study area and zone-wise map for all the zones were created on the map for the year 2004 – 2005 and 2020 – 2021. (Refer Maps Figure 9 Figure 10)

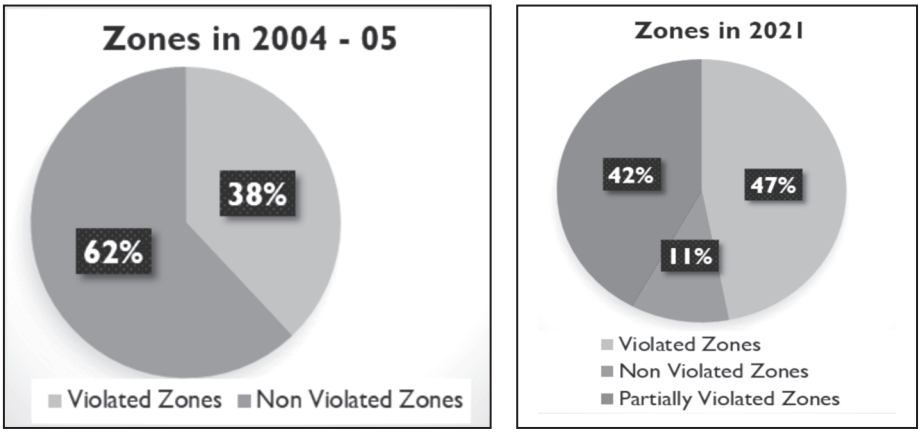


Figure 8: Area of various category Zones in 2004 – 05 and in 2021 (Source: Author)

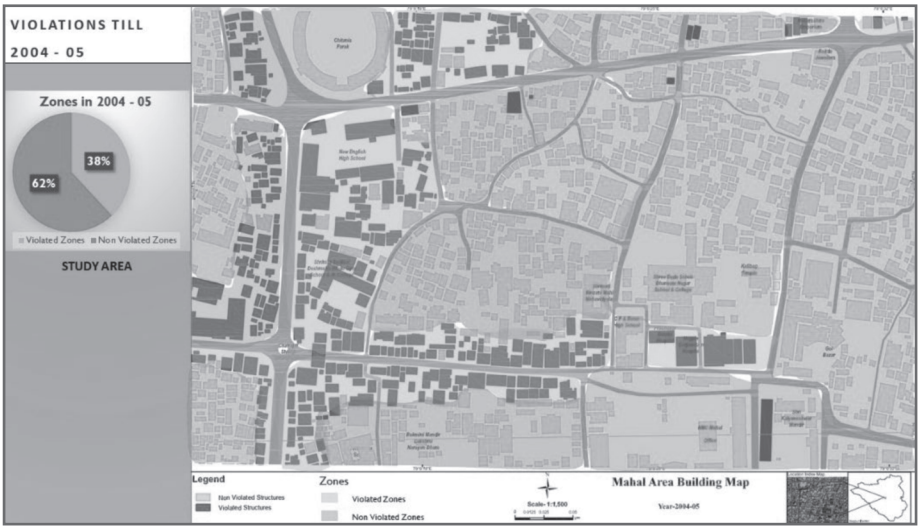


Figure 9: Violation till 2004- 05 (Source: Author)

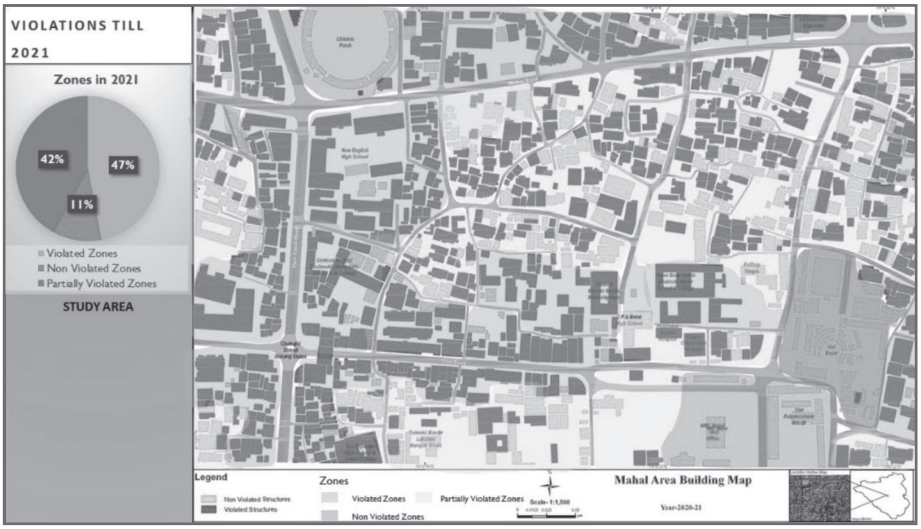


Figure 10: Violations till 2021 (Source: Author)

STAKE HOLDER SURVEY (QUALITATIVE)

It is evident from the literature that there have been certain lapses while preparing the Legal Framework. These were validated by adopting the method of an opinion survey in a questionnaire and interview format from planners, architects, the public, lawyers, sociologists, professionals, and government officials to understand the various stages of preparing the law, and responses were analysed. The survey, conducted among planners, architects, legal professionals, sociologists, government officials, professionals and members of the public, established that even though the DP preparation process is statutory and largely follows a uniform procedure, it is highly rigid and lacks a mechanism specifically addressing the requirements of inner-city areas.

Approximately 95% of respondents stated that building bye-laws are framed considering existing conditions and projected growth; however, 84% reported the absence of an effective evaluation mechanism to assess DP implementation. Similarly, periodic post-implementation review was found to be weak, with 46% of respondents reporting no review meetings, 31% reporting that meetings were rarely conducted and only 23% indicating that such meetings were held.

Public participation was also limited, with 83% of respondents identifying inadequate involvement of citizens beyond the formal stage of objections and suggestions. Furthermore, 86% reported that ground realities were not verified after implementation, indicating that subsequent changes in land use and physical conditions may remain unrecorded in the planning framework, while 96% stated that no systematic assessment or evaluation of the DP and DCRs was undertaken after their preparation. The comparative analysis of DCRs from 1971 to 2022 further indicates limited changes in permitted land uses and regulatory parameters, particularly in established areas, while changes in FSI, ground coverage and density have largely responded to new development rather than the existing conditions of the inner city. The findings therefore establish a clear disconnect between statutory planning provisions and their implementation, particularly in relation to continuous monitoring, periodic evaluation, stakeholder participation and adaptation to changing ground realities. The study accordingly identifies the need for an integrated assessment of the DP and DCRs, supported by periodic review, evidence-based evaluation and greater stakeholder participation, particularly for deteriorating inner-city areas, to facilitate their effective rejuvenation.

OBSERVATIONS, RESULT AND DISCUSSIONS

The study area experienced significant changes between 2004 and 2021, with commercial floor space increased nearly seven times and residential floor space increasing by 1.3 times due to less land area. Although ground coverage majorly has minor changes, the area became more congested due to vertical growth, with commercial floors shifting from G to G+3 buildings. A major rise in commercial buildings and floor space, along with a decline in residential and mixed-use buildings, indicates a clear transition of the area towards commercial dominance on major as well as internal roads. This completely shows that there are major changes in the old city areas which are leading to violations from the legal framework. As discussed in Literature review these violation results into decline of inner-city areas. As per the survey results taken in 2021, majority of the structures were constructed in the violated zones, followed by the partially violated zones. 47% of the site area comprises of violated zone, 42% partially violated zone, and 11% non-violated. The organic unplanned areas with the most violations have no internal system to control the increasing density.

The analysis of the Development Plan (DP) preparation process and Development Control Regulations (DCRs) further identifies institutional and procedural gaps contributing to this condition. The existing DP preparation process does not take into account the review meetings that occur before and after the DP is implemented. The DCRs are prepared by keeping the viewpoint of the projections of the population but not on the clear assessment of the existing working DCR and the on-site condition. The inner-city areas, despite being the most vulnerable to deterioration, receive limited attention within subsequent changes to the DP and DCRs, which are predominantly oriented towards new development. The comparative assessment of DP and DCR provisions also

indicate limited changes in specified land uses, FSI, ground coverage and density between 1971 and 2022. Furthermore, preparation process of DP does not integrate the assessment of the existing DP with the Development Control Regulations and prevailing land use conditions. The findings emphasise the need for coordinated assessment of planning documents, existing land-use patterns and emerging land-use requirements, together with stakeholder participation from the initial stage of DP preparation. In the absence of such periodic assessment and monitoring, deviations and violations accumulate over time and result in the deterioration of inner-city areas.

Based on these findings, the study proposes an Urban Rejuvenation Plan (URP) under the framework of an Urban Rejuvenation Authority (URA). The feasibility of the proposed URA, was validated through comparative international case examples, including Singapore, Oregon and Hong Kong (CM Hui, 2008), and Indian initiatives in Mumbai and Ahmedabad, which determines different approaches to urban renewal. The validation was further supported through expert consultation involving Urban Planners, Architects, Lawyers, a Commissioner of the Local Authority and an Additional Town Planner. The findings indicate that a dedicated institutional mechanism can provide the coordination required between planning, regulation, implementation and post-implementation monitoring. The proposed URA is therefore envisaged not as a replacement for the existing Development Plan and DCR framework, but as a specialised coordinating and regulatory mechanism. The authority would be responsible for preparing and implementing the URP, undertaking periodic assessment and monitoring, coordinating with stakeholders, responding to existing ground realities and determining appropriate type of rejuvenation interventions according to the level of deterioration. The comparative case studies and expert validation consequently establish the institutional and operational feasibility of the proposed URA as a mechanism for addressing violations, deviations and facilitating the systematic and continuous rejuvenation of deteriorating inner-city areas in the Indian context.

RECOMMENDATION AND PROPOSAL

A detailed literature Review of the case examples of various Urban Re Development Authorities was done which had the following inferences

- Dedicated Redevelopment Authorities ensure integrated planning, implementation, and monitoring of urban renewal projects.
- Successful rejuvenation requires a separate statutory authority with clear legal powers and responsibilities.
- Redevelopment should adopt a holistic, area-based approach rather than isolated plot-level interventions.
- Effective authorities integrate redevelopment, rehabilitation, revitalization, and heritage conservation within a single framework.
- Stakeholder participation and public-private partnerships are essential for sustainable urban renewal (Dr. Navneet Munoth, 2018).
- A multidisciplinary structure comprising planning, infrastructure, urban design, finance, and implementation teams improves project outcomes.
- Continuous post-implementation monitoring and review are critical for maintaining rejuvenated areas.
- Redevelopment authorities help coordinate multiple agencies, reducing institutional overlap and implementation delays.
- Urban rejuvenation should address social, economic, environmental, and physical aspects simultaneously.

The legal framework in Western countries does not allow the city and the inner city to spread endlessly, thus rejuvenating the inner cities. The zoning regulations and gentrification policies are very effective to allow the inner city to maintain its character by keeping and preserving its open spaces and paying attention to its built environment (Doucet, 2018).

A Standard operating Procedure was designed for every stage of the plan to make it clearly objective and implementable (Etzioni, 2015). The Rejuvenation Authority ideated to have a plan of action known as the Urban Rejuvenation Plan which would act as a tool kit for the checking of all the town planning activities going on in the inner-city areas (Wilsford, 1994).

The Urban Rejuvenation Authority will be responsible for activities associated with the physical planning, new construction, modification, and completion of any types of projects.

The authority outlines the following stages of work under the following key concerns

- Estimating the existing Condition (Situation Analysis)
- Assessing the existing Conditions in terms of deviations from the existing Legal framework (Assessment)
- Assessing the existing Condition by an assessment Method and working out detailed project reports for neighborhoods to go for options of revival, redevelopment, renovation (Change Management Plan)

The paper proposes modules of rejuvenation which could be implemented at the micro level, by applying the following three appropriate actions to the appropriate zones by the Authority.

1. Reactionary Action
2. Reformatory Action
3. Revolutionary Action

The stages at which these actions could be applied are indicated in the flow chart given below in the Urban Rejuvenation Action Plan.

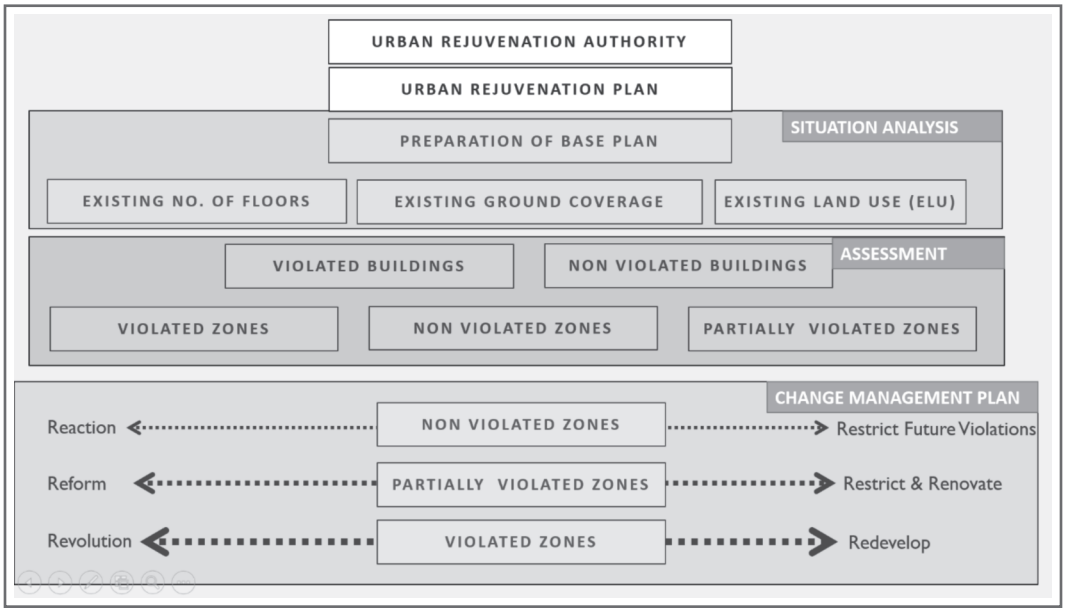


Figure 11: Urban Rejuvenation Action Plan (Source: Author)

Actions of the Authority

1. Reactionary Action

Restriction: The Authority will demarcate various zones - the Most Affected Areas, Partially Affected Areas, and Non-affected Areas. The non-affected areas will go into the process of **restricting the violations.** The violations in the buildings can be further restricted by stringent measures. These buildings will also undergo redevelopment as their tax increments would have reduced and the property would be under deterioration. These zones will go under redevelopment in the last phase of the rejuvenation, as they are the least affected areas.

2. Reformatory Action

Renovation: The zones which are zoned under partially affected areas will go under strict restriction with a layer of heavy fines which will be charged to the violated area as tax, leading to a restrictive action.

This can be called a lease floor space, only for constructed areas and these areas will be renovated by the owner under the control of the authority. No extra FAR will be issued to other buildings. These buildings will also undergo redevelopment as their tax increments would have reduced and the property is in the process of deteriorating. These zones will go under redevelopment in the second last phase of rejuvenation, as they are the partially affected areas (LaSalle, 2013).

3. Revolutionary Action

Redevelopment Process: The most affected areas which are the completely violated zones will undergo the redevelopment process in the following stages;

- Pre-feasibility
- Urban Rejuvenation Plan
- Amendments to the Plan
- Review
- Closing a project (Tax Assessment)

Urban Rejuvenation refers to a step-wise approach from part to the whole with respect to the severity of the condition. After the decline of the inner city, there is a need for re urbanisation which happens only when the area undergoes a process of Urban Rejuvenation. It is a continuous process of rejuvenation that caters to two objectives i.e., to remove the blighted areas and to create funds, and increase taxes on the rejuvenated areas.

CONCLUSIONS

The study establishes that the decline of Indian inner-city areas is not just a consequence of physical deterioration but is linked to shortages within the existing legal framework. The case study of inner city of Nagpur i.e. Mahal, explains that violations related to land use, floor space index, building heights, and ground coverage have increased many folds over the years due to inadequate monitoring and enforcement of Development Plans (DPs) and Development Control Regulations (DCRs). The quantitative analysis pointed towards substantial changes happening in the inner-city areas, commercial activities expanding at the cost of residential and mixed-use land uses, leading to increased congestion and infrastructure stress in the inner city. The categorisation of the study area into violated, partially violated, and non-violated zones helped in understanding the level of degradation which has happened in the area and also the related interventions which can be taken.

The qualitative survey highlighted critical shortcomings in the planning process, including the absence of systematic pre and post implementation assessment, post-implementation review, stakeholder participation, and inter-agency coordination

The study concludes that periodic assessment and continuous monitoring must become integral part of the planning framework.

Rejuvenation of inner-city areas requires a statutory mechanism capable of planning, implementation, enforcement, and review

processes. In this regard, the proposed Urban Rejuvenation Authority (URA) and Urban Rejuvenation Plan (URP) was proposed as a structured framework for addressing urban decline.

The proposed three-tier strategy—Reactionary, Reformatory, and Revolutionary Actions—provided an action plan for different levels of deterioration. The research therefore proposes a shift from conventional growth-oriented planning towards a cyclical, assessment-based urban rejuvenation model that prioritises the rejuvenation of inner cities and also the future city development.

REFERENCES :

- Andrews, A. (2018). Decline and the City: the Urban Crisis in Liverpool. School of History, Politics and International Relations University of Leicester.
- Andy Pike, D. M. (2016). Uneven growth: tackling city decline. Joseph Rowntree Foundation.
- Beattie, M. (2003). Colonial Space: Health and Modernity in Barabazaar, Kolkata. TDSR.
- Bertaud, A. (2004). Mumbai FAR conundrum: The perfect storm: the four factors restricting the construction of new floor space in Mumbai.
- Bharathi, V. (2003). Restructuring of City Core, Case Study Bareilly.
- Bhattacharya, S. &. (Summer 2011). Postcolonial global cities: The Indian experience. The Newsletter|No.57|.
- Bissel, W. C. (2011). Between Fixity and Fantasy: Assessing the Spatial Impact of Colonial Urban Dualism. Journal of Urban History.
- Bourne, L. (1978). PERSPECTIVES ON the Inner City: Its Changing Character, Reasons for Decline and Revival. Centre for Urban and Community Studies : University of Torento.
- Burgess, E. W. (2008). The Growth of the City: An Introduction to a Research Project. “The trend of population”. Publications of the American Sociological.
- (2019). Census of India 2011. New Delhi: National Commission on Population Ministry of Health & Family Welfare.
- Chattopadhyay, S. (2000). Blurring Boundaries - The Limits of "White Town" in Colonial Calcutta. Journal of the Society of Architectural Historians.
- Christopher. M Lawin. (2018). The Uncertain Future of The Urban Core. Routledge.
- CM Hui, J. T. (2008). A review of the effectiveness of urban renewal in Hong Kong. Property Management.
- Corporation, N. M. (2019). Zone Map . Nagpur, Maharashtra, India.
- CRISIL. (March 2015). City Development Plan for Nagpur, 2041. Nagpur: Capacity Building for Urban Development project (CBUD).
- D Adams, E. H. (2001). Urban renewal in Hong Kong: Transition from development corporation to renewal authority. Land Use Policy.
- Daquan Huang, Z. L. (2015). Monocentric or Polycentric? The Urban Spatial Structure of Employment in Beijing. Open Access.
- Development, O. F.-O. (2001). Governance in the 21st century. OECD .
- Dickenson, C. P. (2011). The Agora in the Mediterranean from Homeric to Roman Times. International Conference KOS.
- Doucet, B. (2018). From “Big Small Town” to “Small Big City”: Resident Experiences of Gentrification along Waterloo Region’s LRT Corridor. Journal of Planning Education and Research.

- Dr. Bharath H Aithal, C. M. (2017). Modelling the growth of two rapidly urbanizing Indian cities. Journal of Geomatics, 2017.
- Dr. Navneet Munoth, D. J. (2018). The Integrated Approach Towards Inner-City Sustainability In Today's Context: Nagpur, India. International Conference on Urban Sustainability: Emerging Trends, Themes, Concepts and Practices.
- Etzioni, A. (2015). Mixed-Scanning: A "Third" Approach to Decision-Making. JSTOR.
- Faetanini, M. (2010). Historic Districts for All - India. UNESCO Publishing.
- GLAEconomics. (2008). London's Central Business District: Its global importance. Greater London Authority.
- Glaeser, E. L. (2019). Urbanization And Its Discontents. Harvard University and NBER.
- Government of India, M. o. (2015). Urban and Regional Development Plans Formulation and Implementation Guidelines Volume I. Town and Country Planning Department.
- Greener, I. (2002). Understanding NHS reform: the policy-transfer, social learning and path-dependency perspectives'. Governance.
- Guerrieri, P. M. (2020). Migration, translation, and transformation of western urban planning models. City, Territory and Architecture .
- Hahn, J. (2011). Cities of tomorrow Challenges, visions, ways forward. European Union, 2011.
- Hansen, R. (2002). Globalization, embedded realism and path dependence: the other immigrants to Europe. Comparative Political Studies.
- Ijeoma, E. O. (2007). Rationality, disjointed incrementalism and mix scanning theories for decision-making on globalisation. School of Public Management and Administration.
- Junhua, L. (2022). E-Government Survey 2022. United Nations Newyork 2022.
- Kanchanamala, P. D. (October - December 2011). An Analysis of Growth Dynamics in Chennai Metropolitan Area. Institute of Town Planners, India Journal.
- Karrsenberg, H. (2015). The City at Eye level. Eburon.
- Khakzand, M. (2016). Mixed Use Development, A Solution For Improving Vitality Of Urban Space. Research Gate.
- King, A. (2004). Spaces of Global Cultures: Architecture, Urbanism, Identity. Taylor & Francis.
- King, L. J. (1985). Central Place Theory. Sage Publication: 1985.
- LaSalle, J. L. (2013). Handbook on Redevelopment. Publication: The Times of India Mumbai; In Association with Jones Lang LaSalle.
- Lawin, C. M. (2018). The Uncertain Future of The Urban Core. Routledge.
- Leo, C. (1999). Inner-City Decay In Winnipeg: Causes And Remedies. University of Winnipeg.
- Masahisa Fujita, P. K. (2000). The Spatial Economy: Cities, Regions, and International Trade . Southern Economic Journal.
- Mateo-Babiano, I. B. (2013). Vertical Mixed Use Communities, a compact city model. State of Australian Cities Conference .
- Matthew S. Westfall, V. A. (2001). Urban Indicators For Managing Cities. Asian Developer Bank.
- Melville, S. &. (2001). Research Methodology: An Introduction. Lansdowne.
- Meshram, D. (2011). Dynamic Growth of Cities and Tardy Plan Preparation and Approval Processes: A case study of the

Nagpur. Institute of Town Planners, India Journal.

- Middleton, D. A. (2009). Growth and Expansion in Post-War Urban Design Strategies:C. A. Doxiadis and the First Strategic Plan for Riyadh Saudi Arabia (1968-1972). Georgia Institute of Technology.
- Mirza, S. (2010). Strategic Urban Planning and Design Tools for Inner City Regeneration. 46th ISOCARP Congress.
- Mnikathi, Z. P. (2016). An analysis of the socio-economic impact of inner city urban regeneration as a strategy against urban decline: The Case of Durban Point Precinct Development. University of KwaZulu-Natal.
- Mukhopadhyay, A. (2015). Legal Framework for Urban Planning and Management. Research Gate.
- Mumford, A. P. (1999). The slow death of great cities? Joseph Rowntree Foundation 1999.
- Munshi, R. J. (2019). Development Plan Preparation In Indian Cities: A Comparative Analysis of Five Million Plus Cities. Research Gate.
- Nam, H. W. (2014). Shrinking Cities: A Global Percepective, 2014. Routledge, Taylor & Francis Group, London & Newyork.
- Nightingale, J. (2006). Brisbane: The 200 Kilometre City or Just another Port Town. Urban Policy and Research.
- Niroop Abbu, L. B.-G. (2015). Urban green Growth Strategies for Indian Cites, Volume 1. New Delhi - 110020, India: ICLEI - Local Governments for Sustainability, South Asia.
- Operations, S. P. (n.d.). Sao Paulo Municipal Government. Urban Operations. Sao Paulo Municipal Government.
- Parr, J. (2012). The Spatial-Cycle Model Revisited. Research Gate.
- Pattrick, G. (1915). Cities in evolution: An introduction to the town-planning movement and the study of cities. London: Williams and Norgate.
- Peiser, R. B. (1989). Density and Urban Sprawl. University of Wisconsin Press.
- Pierson. (2000). Increasing returns, path dependence and the study of politics. American Political.
- Rathor, A. B. (2017). Dynamic Growth of Bhopal City Core: A Conceptual and Legal Approach. International Journal on Emerging Technologies.
- (2001). Revised Development Plan. of Nagpur 1986–2011. Nagpur: Town Planning Department: Maharashtra, India, 2001.
- Sab, E. C. (2010). Urban decline and shrinking cities: A critical assessment of approaches to urban regression. Research Gate .
- Salari M, i. S. (2017). Analyzing the Role of Constructional Violations in the Failure of Urban Development Plans of the Tehran Metropolis. Tehran: Research Gate.
- Sarkar, A. K. (2016). Historic Architecture & The Ancient Art Of Planning: The Era Forgotten. Civil Engineering and Urban Planning: An International Journal.
- Schacherl, B. (2008). Assessing Smart Growth in San Antonio, Texas. the Department of Political Science.
- Schmidt, C. W. (2004). Sprawl: The New Manifest Destiny? Environmental Health Perspectives.
- Shaw, C. L. (2015). Inner-City Decay In Winnipeg: Causes & Remedies. University of Winnipeg.
- Shirish Sankhe, A. M. (2020). India's Turning Point. Mckinsey Global Institute .

- Simon EliasBibriab, J. K. (November 2020). Compact city planning and development: Emerging practices and strategies for achieving the goals of sustainability. Elesvier.
- Sridhar, K. S. (2010). Impact of land use regulations on suburbanisation: evidence from India's city. INSTITUTE FOR SOCIAL AND ECONOMIC CHANGE.
- Stafford, C. R. (1992). Urban Theory, Urbanism, and Suburban Residence. JSTOR.
- Steinberg, F. (2008). Revitalization of Historic Inner city areas in Asia. Ha Noi Jakarta Manila: Asian Development Bank.
- Sykes, P. R. (2000). Urban Regeneration: A Handbook. London: SAGE Publication.
- Taft, C. E. (2018). Deindustrialization and the Postindustrial City, 1950–Present.
- Tahsildae, N. S. (2003). Restructuring Core Area of Panjim City.
- Team, U.-H. C. (2022). Envisaging the Future of Cities- World Cities Report 2022. United Nations Human Settlements Programme (UN-Habitat).
- Team, W. E. (2017). Migration and Its Impact on Cities. Geneva: World Economic Forum.
- Tewari, M. (2016). Better Cities, Better Growth: India's Urban Opportunity. UNC · Department of City and Regional Planning and Program in Global Studies.
- (2017). The Maharashtra Regional and Town Planning Act, 1966.
- (2022). Unified Building Byelaws.
- (2015). Urban and Regional Development Plans Formulation and Implementation Guidelines. New Delhi: Ministry of Urban Development.
- (2017). Urban Legislation Unit Working Document - Planning Law Assessment Framework. UN-Habitat.
- Urban Redevelopment Authority (URA), S. (n.d.). Rejuvenating our Downtown – Master Plan 2025. URA Singapore.
- Urban Renewal Authority, H. K. (n.d.). Urban Renewal Strategy.
- Uzonwanne, F. (2016). Rational Model of Decision Making. Research Gate.
- Verma, A. (2016). Urban Renewal in Core Area of Jaipur.
- Vernon, E. M. (1959). Anatomy of a Metropolis: The Chang ing Distribution of People and Jobs Within the New York Metropolitan Area. Cambridge, Mass.: Har vard University Press.
- Vicino, T. (2007). The Fate of Inner Suburbs: Evidence From Metropolitan Baltimore. Research Gate.
- (2011). Ward Map 2011. Nagpur Municipal Corporation.
- William Little and Little, W. (2016). Edition, Introduction to Sociology – 2nd Canadian. BC campus.
- Wilsford, D. (1994). Path dependency, or why history makes it difficult but not impossible to reform health care systems in a big way. Journal of Public Policy.

Impact of Extension Education on Sustainable Rural Development

Dr. Tehseen R. Choudhary

Assistant Professor, P. G. Department of Extension Education
L.A.D. and Smt. R.P. College for Women, Nagpur

Abstract

Extension education plays a significant role in promoting sustainable rural development by transferring knowledge, improving skills, encouraging innovation, and empowering rural communities. There are various technologies and innovations which are being developed for the upliftment and welfare of the community people, especially for the Indian rural masses. But the rural people are not aware about these technologies and how it will help them in their future. These technologies will not only help the community people reduce their labour, but also will help them gain financial benefits. Extension Services and Agencies acts as a bridge between research institutions, government agencies, and rural people by helping farmers and communities adopt improved agricultural practices, environmental conservation methods, and livelihood strategies. This research paper examines the impact of extension education on sustainable rural development, focusing on agricultural productivity, social empowerment, economic growth, and environmental sustainability. The study highlights that effective extension services contribute to improved resource management, poverty reduction, and community participation.

Keywords: Extension education, sustainable development, rural development, agriculture, empowerment, innovation

Introduction:

Rural areas are the foundation of many economies, especially in developing countries where agriculture and natural resources provide livelihoods for a large population. However, rural communities often face challenges such as low productivity, lack of awareness, poverty, unemployment, climate change, and limited access to modern knowledge. Rural areas in India are blessed with ample amount of natural resources, but the people are not aware how to use them in accordance.

Extension education is a process of educating rural people through non-formal learning methods to improve their knowledge, attitudes, and skills. It is widely used in agriculture, rural development, health, and community welfare programmes. It enables individuals and communities to solve problems by using their available resources, adopt improved technologies for their welfare and participate in development activities organised by the community planners and government. Extension education encourages better living standard through training and education, by which people can improve and learn new skills.

Sustainable rural development aims to improve the quality of life of rural populations while maintaining ecological balance and ensuring resources for future generations. It aims to improve the quality of life of rural people through balanced and long-term development. Sustainable rural development creates employment opportunities and improves income sources for rural communities. It also promotes farming practices that increase productivity while protecting soil, water, and biodiversity. Social development is gained through education, health care, sanitation and basic infrastructure. Other than this, community participation is also encouraged where local community people are involved in planning, organizing and also evaluating developmental programmes for their betterment. Sustainable rural development focuses on achieving economic progress, social well-being, and environmental protection together. It helps communities become more self-reliant and resilient while preserving natural resources. As it is clearly stated by Chen J. et. Al. in their research, “Strengthening Agricultural Extension for Sustainable Rural Development:

Insights from Global Experiences", that the findings from the research emphasize the need for pluralistic extension models that combine public, private, and community-based approaches to address diverse agricultural contexts. Key recommendations include strengthening policy frameworks, investing in digital infrastructure, and fostering participatory methodologies to enhance the resilience and inclusivity of extension services." It is clear from the above research that, a lot of extension models are required in combination to improve the sustainable agricultural needs and production.

Extension education contributes to sustainable rural development by promoting scientific farming, entrepreneurship, community participation, and responsible use of natural resources.

Objectives of the Study

The objectives of this research paper are:

1. To understand the role of extension education in rural development.
2. To examine the impact of extension education on agricultural productivity.
3. To analyze its contribution toward social, economic, and environmental sustainability.
4. To identify challenges affecting effective extension services.

Role of Extension Education in Sustainable Rural Development

I. Improvement in Agricultural Productivity

Extension education plays a vital role in sustainable rural development by helping rural people specially farmers gain knowledge, skills, attitude needed to access improved agricultural technologies, crop management practices, pest control methods, and climate-smart farming techniques. Through training programs, demonstrations, and farmer field schools, extension workers encourage farmers to adopt efficient practices that increase production and reduce losses. Through extension education farmers are introduced with improved agricultural technologies, new farming practices, crop diversification, modern technology and climate smart farming methods. It also encourages the adoption of sustainable farming techniques.

Through extension education capacity of rural masses, especially youth, women in agriculture, livestock, entrepreneurship and resource management are built. It also helps farmers reduce environmental degradation and improves long term productivity, water conservation, soil health management

II. Promotion of Sustainable Farming Practices

Sustainable farming practices aim to increase agricultural productivity while protecting the environment, conserving natural resources, and ensuring long term food security. Extension education plays a key role in promoting these practices among farmers. Key sustainable farming practices includes:

1. Organic farming
2. Integrated nutrient management (INM)
3. Integrated pest management (IPM)
4. Water conservation
5. Soil conservation
6. Crop diversification
7. Agroforestry
8. Climate smart agriculture
9. Effective waste management
10. Farmer education and awareness

Benefits of sustainable farming practices:

1. Conserve soil and water resources
2. Protects biodiversity and the environment
3. Reduce production cost
4. Improves soil fertility and long term productivity
5. Enhances food security and farmer's income

6. Builds resilience to climate change.

Promoting sustainable farming practices ensures productive agriculture while preserving natural resources for future generations. Through education, training and the adoption of eco-friendly technologies farmers can achieve higher productivity, environmental protection and sustainable rural development. By increasing awareness about environmental issues, extension services help rural communities protect biodiversity and maintain ecological balance.

III. Economic Empowerment and Poverty Reduction

Economic empowerment is the process of enabling individuals and communities to improve their income, productivity and financial independence. Poverty reduction involves creating opportunities that help people help meet their basic needs and achieve a better standard of living. Extension education contributes significantly to both by providing knowledge, skills and access to resources. It supports rural economic development by improving skills and encouraging income-generating activities. It promotes:

- Livestock management
- Skill development
- Income diversification
- Technology adoption
- Market linkage
- Access to credit and government schemes
- Women and youth empowerment
- Financial literacy
- Employment generation
- Small-scale enterprises
- Value addition of agricultural products
- Entrepreneurship development

Farmers and rural youth who receive training are better able to create employment opportunities and improve their economic conditions.

IV. Social Development and Community Participation

Social development is the process of improving the quality of life, equality, education, health and social well being of individuals and communities. Community participation refers to the active involvement of people in identifying their needs, planning organising, evaluating development programmes. Extension education encourages both to encourage awareness, cooperation and collective actions. Extension education encourages participation among rural people by involving them in decision-making processes. It strengthens local organizations, self-help groups, and community-based initiatives. Women and youth benefit from extension programs through skill development, leadership opportunities, and increased involvement in rural development activities.

Role of extension education

1. Community mobilization
2. Education and awareness
3. Women empowerment
4. Youth development
5. Leadership development
6. Social Development & Community Participation
7. Strengthening community organization
8. Promoting social equality
9. Conflict resolution

By promoting the above it improves quality of life and social welfare. Increase community ownership of development programmes, strengthen local institution and leadership, and at the end promotes inclusive and sustainable rural development

V. Climate Change Adaptation

Climate change adaptation refers to the process of adjusting agricultural practices, livelihood and community systems to cope up with the impacts of climate changes like rising temperature, irregular rainfall, drought, floods

and extreme weather events. Extension education helps farmers adopt adaptive practices to reduce risk and improve resilience. Role of extension education in climate change adaptation:

1. Awareness creation
2. Promotion of climate smart agriculture
3. Water resource management
4. Soil conservation
5. Crop diversification
6. Weather and early warning information
7. Disaster risk management
8. Capacity building.

Challenges in Extension Education

Extension education is essential for rural and agricultural development, but its effectiveness is limited by financial, institutional, technological, environmental and socio-economic challenges. Addressing these issues through increased investment, capacity building, stronger research linkage, digital extension services and farmer participation can improve the success of extension programmes. Despite its importance, extension education faces several limitations:

1. Limited availability of trained extension personnel.
2. Lack of adequate funding.
3. Low literacy level among rural masses
4. Resistant to change.
5. Weak research-extension-farmer linkages
6. Limited access to information and ICT
7. Small and fragrant land holding
8. Climate change and environmental challenges
9. Poor communication between researchers and rural communities.
10. Lack of infrastructure and financial support.
11. Low participation of some rural groups.
12. Difficulty in reaching remote areas.
13. Changing climate and technological demands.

Addressing these challenges is necessary to improve the effectiveness of extension services.

Suggestions for Improving Extension Services

- Increase investment in rural extension programs.
- Use digital technologies for wider knowledge dissemination.
- Strengthen cooperation between farmers, researchers, and government agencies.
- Promote farmer's training and workshop.
- Promote climate smart agriculture.
- Improve monitoring and evaluation.
- Encourage participatory approaches where farmers contribute to decision-making.
- Provide regular training to extension workers.
- Focus on women and youth involvement.

Conclusion

The study concludes that extension education plays a pivotal role in achieving sustainable rural development by facilitating the transfer of knowledge, skills, technologies, and innovations to rural communities. It empowers farmers and rural households to adopt improved agricultural practices, diversify their livelihoods, conserve natural resources, and enhance their socio-economic well-being. Through participatory approaches, capacity building, and effective communication, extension education promotes informed decision-making, community participation, and self-reliance, which are essential for long-term rural development.

Furthermore, extension education contributes to sustainable development by encouraging environmentally sound farming practices, strengthening local institutions, promoting gender equity, and improving resilience to climate change and other rural challenges. However, its effectiveness depends on adequate infrastructure, trained extension personnel,

supportive government policies, the integration of digital technologies, and active collaboration among public, private, and community stakeholders.

Overall, extension education serves as a vital catalyst for sustainable rural development by bridging the gap between research and practice, fostering inclusive growth, and improving the quality of life in rural areas. Strengthening extension systems through innovation, continuous learning, and community-centered approaches will be essential to achieving sustainable and resilient rural development in the future.

REFERENCES

- Adhikary, M. M. (2019). Perspective of Extension Education. Astral International Pvt. Ltd.
- Bansal, V. (2021). Extension Education & Rural Development. Agrotech Publishing Academy.
- Chang, C. W. (1963). Extension Education for Agricultural and Rural Development. Food and Agriculture Organization (FAO).
- Chen J. et.al. (2023) Strengthening Agricultural Extension for Sustainable Rural Development: Insights from Global Experisnces".
- Crouch, B. R., & Chamala, S. (1981). Extension Education and Rural Development (Vols. 1 & 2). John Wiley & Sons.
- Dahama, O. P., & Bhatnagar, O. P. (1993). Education and Communication for Development. Oxford & IBH Publishing Co.
- De, D., & Jirli, B. (2010). A Handbook of Extension Education. Agrobios (India).
- Leal Filho, W., Tortato, U., & Frankenberger, F. (Eds.). (2021). Integrating Social Responsibility and Sustainable Development. Springer.
- Mohanty, S. R. (2017). Home Science Extension Education and Rural Development. Anchor Academic Publishing.
- Maunder, A. H. (1972). Agricultural Extension: A Reference Manual. Food and Agriculture Organization (FAO).
- Rogers, E. M. (2003). Diffusion of Innovations (5th ed.). Free Press.
- Swargiary, K., & Roy, K. (2023). Extension Education. Scholar's Press.
- Van den Ban, A. W., & Hawkins, H. S. (1996). Agricultural Extension (2nd ed.). Blackwell Science.

Emotional Stability and Resilience of Adolescents: A Correlational Study

Ms. Anagha Yarnal* and Dr Shraddha Thacker**

*Research Scholar Department of Human Development

**Correspondence author, Asst. Professor, L.A.D. and Smt. R.P. College for Women, Nagpur

Abstract

The present study was conducted to examine the relationship between emotional stability and resilience among adolescents. Adolescence is a crucial stage of development marked by various physical, emotional, and psychological changes that often create challenges in adjustment and coping. Emotional stability helps individuals maintain emotional balance during stressful situations, while resilience enables them to adapt and recover from adversity. The study was carried out on a sample of 60 adolescents aged between 16 and 20 years selected through random sampling. Emotional stability was measured using the NEO-FFI-3, and resilience was assessed using the Resilience Scale developed by Wagnild and Young (1993). Data were collected through online administration of the tools and analysed using descriptive statistics and Pearson's coefficient of correlation. The findings revealed that all participants exhibited low levels of emotional stability. Further, 70% of the adolescents showed moderately low to low levels of resilience, while 30% demonstrated moderately high to high resilience. The correlation analysis indicated a positive but weak relationship (r = 0.1639) between emotional stability and resilience. The study concludes that although emotional stability and resilience are positively related, the strength of the relationship is limited.

Introduction:

Growing up has never been easy. Developmental changes in emotion include increased understanding of compound emotions. As children get older they use a great variety of coping strategies which gives them strength to cope with hardship or uncertainty. Life may not come with a map, but everyone will experience twists and turns, from everyday challenges to traumatic events with more lasting impact like the death of loved one, life altering accidents, or a serious illness. Each change affects the person differently bringing a unique flood of thoughts, strong emotions and uncertainty. Yet people generally adapt well overtime to life changing situations and stressful situations. Life isn't always going to be easy – but it shouldn't always be hard. Whatever one resists, persists, so learning how to let go and adapt to change and adversity can really help move into a new mind set, and develop more resilience along the way.

Being an adolescent is hard work. It is a period of significant physical, emotional and psychological change as children transit to young adulthood. During these years, adolescents are faced with numerous social, emotional and moral challenges, which they often find hard to deal, given that they are still learning how to manage strong emotions and their brains are in a period of significant development. Adolescence is considered as a period of stress and storm. Stress is associated with increased incidence of mental and physical health problems and decreased wellbeing. But remarkably, not all who have been exposed to toxic stress or adversity develop these problems there are individuals undergoing adversity who remain relatively untouched exhibiting what is generally referred to as Resilience.

What is Resilience? Resilience is the process of being able to adapt well and bounce back quickly in times of stress. This stress may manifest as family or relationship problems, serious health problems, problems in the workplace or even financial problems to name a few. Developing resilience can help cope adaptively and bounce back after changes, challenges, setbacks, disappointments, and failures. Resilience has been defined in numerous ways, including the following:

"…the ability to bounce back from adversity, frustration, and misfortune…" (Ledesma2014).

"The developable capacity to rebound or bounce back from adversity, conflict, and failure or even positive events, progress, and increased responsibility." (Luthans 2002).

"…a stable trajectory of healthy function after a highly adverse event." (Bonanno et al 2004, 2011).

"…the capacity of a dynamic system to adapt successfully." (Masten 2014, Southwick 2014).

Psychologists define resilience as the process of adapting well in the face of adversity, trauma, tragedy, threats, or significant sources of stress such as family and relationship problems, serious health problems, or workplace and financial stressors. As much as resilience involves "bouncing back" from these difficult experiences, it can also involve profound personal growth.

The **American Psychological Association (2014)** defines resilience as "the process of adapting well in the face of adversity, trauma, tragedy, threats or even significant sources of stress. Developing resilience is a very personal process. Each of us reacts differently to stress and to trauma. Some people bounce back quickly while others tend to take longer.

Traits, Qualities, and Characteristics of the Resilient Person: According to Conner and Davidson (2003), resilient people have certain characteristics. These characteristics may include:

- Viewing change as a challenge or opportunity
- Commitment
- Recognition of limits to control
- Engaging the support of others
- Close, secure attachment to others
- Personal or collective goals
- Self-efficacy
- Strengthening effect of stress
- Past successes
- Realistic sense of control/having choices
- Sense of humour
- Action-oriented approach
- Patience
- Tolerance of negative affect
- Adaptability to change
- Faith

People who have low resilience may feel:

- Depressed
- Victimized
- Demoralized
- Hopeless
- Disconnected
- Tired or fatigued
- Stressed out
- Find it difficult to continue

The Main Factors Contributing to Resilience: There are many ways to increase resilience. Some of those include having a good support system, maintaining positive relationships, having a good self-image and having a positive attitude. Other factors that contribute to resiliency include:

- Having the capacity to make realistic plans.
- Being able to carry out those plans.
- Being able to effectively manage feelings and impulses in a healthy manner.
- Having good communication skills.
- Having confidence in strengths and abilities.
- Having good problem-solving skills.

A resilient person understands that success or failure in one area of life often affect all the other areas of life as well. Having a positive outlook of the future and developing a growth mind set is probably one of the simplest things one can do to build resilience. Cultivating a growth mind set involves the desire to be open and adaptable and learning to change. There are many factors which influence resilience. These include

emotional quotient, perception and acceptance of events, exposure to mild frustrations during early years of life, emotional stability etc.

Emotional stability is the capacity to maintain one's emotional balance under stressful circumstances. Emotionally stable persons tolerate minor stresses and strains of day to day living without becoming emotionally upset, anxious, nervous, tense, or angry. They are able to maintain serenity under minor emotional stress. They are fairly constant in their basic mood, and they generally revert quickly to that state following those occasions when they have experienced considerable stress or have been exceptionally provoked. The unstable person, on the other hand, is subject to fairly wide, frequent, and often unpredictable mood shifts that may swing from pole to pole.

Emotional stability enables the person to develop an integrated and balanced way of perceiving the problems of life. This organizational ability and structured perception help one to develop reality-oriented thinking, judgment and evaluation ability. One develops feelings, perceptions and attitudes that help in understanding the realities of life and conditions and circumstances that create miserable situations in life. Such understanding helps one promote his ego strength.

Thorndike and Hagen (1969) considered that emotional stability of a person is characterized by evenness of moods, intent, interests, optimism, cheerfulness, composure, feeling of being in good health, freedom from feeling of guilt, worry or loneliness, freedom from day dreaming, freedom from perseveration of ideas and moods. Smithson (1974) has viewed emotional stability as a multi-trait non-cognitive psychological concept. He defines emotional stability as 'a process in which personality is continuously striving for greater sense of emotional health both intra-psychically and intra-personality. Emotional stability is a desirable trait, it means one can withstand difficult situations, handle adversity, and remain productive and capable throughout.

Aim: To study the relation between Emotional Stability and Resilience among adolescents.

Objectives:

- To study Emotional Stability of adolescents.
- To measure Resilience of adolescents.
- To study the correlation between Emotional Stability and Resilience among adolescents.

Justification of the Study: Adolescence is a crucial developmental period characterized by rapid physical, emotional, cognitive, and social changes. During this phase, adolescents encounter various academic, interpersonal, and environmental challenges that can influence their emotional well-being and overall adjustment. Emotional stability plays a significant role in helping adolescents manage their emotions effectively, maintain psychological balance, and cope with daily stressors. At the same time, resilience enables them to adapt positively to adversity, recover from setbacks, and continue their developmental journey successfully. In today's rapidly changing and demanding world, understanding the levels of emotional stability and resilience among adolescents has become increasingly important. Thus, the present study was conducted to examine the relationship between these two psychological constructs to provide valuable insights into adolescent mental health and adjustment.

Review of Literature:

Alhajri R., Castor N. and Elmassioui F. (2020) aimed at exploring the impact of parental treatment on resilience in adolescents. A descriptive method was adopted to collect preliminary information through a questionnaire designed to achieve study objective. Study sample consisted of 100 adolescents aged 15-22 years. The result showed that adolescents had high resilience. In addition, the results explained that there is an impact of parental treatment methods on resilience in adolescents.

Sharma S. (2020) examined the difference between boarding and day scholars' adolescent boys in terms of emotional stability and medium of instruction. The sample of the study consisted of 24 boarders and 28- day scholars. The data was collected using an emotional stability test for children (ESTC). Statistical analysis was done using t-test. The results indicated a significant difference between boarding and day scholar adolescent boys concerning emotional stability and no significant difference was found in emotional stability of adolescent boys concerning medium.

Bajaj B., Gupta R and Sengupta S. (2019) studied a meditation model where mindfulness is indirectly related to happiness through emotional stability and self- esteem. A sample was collected from 302 undergraduate students. The data was collected using self-report questionnaire of mindfulness, emotional stability, self-esteem and happiness. The results of the study showed that emotional stability and self-esteem are associated with the process of mindfulness and happiness relationship.

Chandelkar S. and Shetty V. (2019) analysed the relationship between resilience, emotional stability and perceived stress between boys and girls. The participants 10th graders, boys and girls were administered three scales, Resilience scale by Wagnild and Young, Emotional stability scale by A. S. Patel and Perceived stress scale by Sheldon Cohen. The data was analyzed, using the t test and correlational coefficient. The t values obtained for resilience, emotional stability and perceived stress scores of boys and girls having both parents working or single parent working did not indicate any significant difference.

Choudhary and Shalini (2019) explored the relationship between emotional intelligence and resilience and examined the gender differences in resilience. Purposive and non-probability sampling was employed for data collection. The sample size of study was109, data was collected using Resilience Scale for Children and Adolescents (RSCA) and Schutte Emotional Intelligence Scale (SEIS) t-test was used to compare the means of two groups on resiliency. Pearson correlation was used to find the relationship between resiliency and emotional intelligence. Findings indicated that the scale were highly reliable for use on selected population, there was moderate positive correlation between emotional intelligence and resilience for the combined sample of male and female adolescents.

Research Methodology

Sample: As a part of the pilot study the effective sample of the study comprised of 60 adolescents of age 16-20 years. The sample was collected randomly from the Nagpur region.

Tool used: NEO-FFI-3, by (Costa and McCrea, 1992) The NEO-FFI-3 is a personality inventory based on the Five-Factor Model of personality. The NEO-FFI is in a brief comprehensive measure of personality traits that provides score for each of five major domains (factors) of personality characteristics: Neuroticism, Extraversion, Openness to experience, Agreeableness and Conscientiousness. Form S consists of 60 items and each of five dimensions is assessed by 12 statements, for each statement, the participants rate themselves on a five-point likert scale from 0-4, with verbal anchors of Strongly Disagree (SD), Disagree(D), Neutral(N), Agree(A), Strongly Agree (SA). Twenty-seven items on the inventory are reversed score. Internal consistencies for the five 12-item Form S NEO-FFI-3 domain scales ranges from .71 to .87 for middle-school children, .72 to .83 for adolescents, and .79 to .86 for adults (McCrae & Costa, 2007). The NEO-FFI can be administered individually or in groups. Both machine and hand-scoring sheets are available.

Resilience Scale (RS) by Wagnild and Young (1993), is a 25-item self-report questionnaire to identify the degree of individual resilience. The RS is a reliable and valid tool to measure

resilience. (Wagnild & Young, 1993). Reliability Cronbach's alpha ranges from .87 to .95. A variety of methods have been used to assess the construct validity of the Resilience Scale and the accumulation of this evidence over the years supports and continues to support the construct validity.

Procedure of data collection: As a part of pilot study the subjects were contacted individually. Rapport was built and as per their convenience data was collected. Confidentiality of the responses was assured. The subjects were explained the purpose of collecting information and were requested to fill the forms. They were thanked for their cooperation.

Hypotheses:

"There exists significant positive relation between Emotional Stability and Resilience among adolescents"

Statistical Analysis: Initially the data was subjected to mean and SD. For inferential purpose the data was treated with Pearson's correlation of coefficient.

Results and Discussion: The first objective of the study was to assess the levels of Emotional stability of adolescents. The results are displayed in the following tables:

Table:1:
Frequency and Percentage of level of Emotional stability

Level of Emotional Stability	Frequency and Percentage
High	NIL (0%)
Average	NIL (0%)
Low	60 (100%)

From above table 1, it is revealed that 100% of the adolescents exhibited low emotional stability, indicating that adolescents may be experiencing considerable emotional fluctuations, stress, anxiety, and difficulty in managing their emotions effectively. This finding can be understood in the context of the developmental challenges of adolescence, which include rapid physical maturation, identity formation, academic pressure, peer influence, social media exposure, and uncertainty regarding future goals. These factors often make adolescents more vulnerable to emotional instability and psychological distress.

The findings are supported by a study conducted by Konika Khuraijam (2024), in Manipur, which highlighted that adolescents are increasingly susceptible to emotional instability due to hormonal changes, social pressures, and mental health challenges during the transition from childhood to adulthood. The study emphasized the growing concern regarding emotional well-being among Indian adolescents and the need for timely interventions.

Further support comes from a recent study by Sharma and Sigh (2024) which reported that Indian adolescents face significant emotional regulation difficulties due to academic expectations, socio-cultural pressures, and technology-related stress. The study found that emotional regulation skills could be improved through structured interventions, indicating that emotional instability is a prevalent concern among adolescents. The finding that all adolescents demonstrated low emotional stability suggests a widespread vulnerability to emotional disturbances during adolescence. Contemporary Indian research indicates that increasing academic demands, social pressures, and rapid psychosocial changes contribute significantly to emotional instability among adolescents. Therefore, there is a pressing need for school-based mental health programs, emotional skill training, and resilience-building interventions to promote adolescent well-being. The second objective of the study was to assess the levels of Resilience among adolescents. The results are in table 2:

Table: 2:
Frequency and Percentage of level of Resilience

Level of Resilience	Frequency and Percentage
Moderately high to high	18 (30%)
Moderately low to low	42 (70%)

From the table 2, it is revealed that 70% of adolescents demonstrated moderately low to low levels of resilience, while only 30% exhibited moderately high to high resilience. This finding suggests that a majority of adolescents may experience difficulties in effectively coping with stress, adversity, and everyday challenges. Adolescence is a period marked by academic pressure, peer expectations, family concerns, social media influence, and uncertainty about the future. These developmental and environmental stressors can weaken adolescents' capacity to adapt positively to adverse situations, resulting in lower resilience levels. The finding further indicates the need for strengthening protective factors such as emotional support, positive coping strategies, life skills, and mental health interventions to enhance resilience among adolescents. A similar observation was reported by Singh (2024), who studied Indian adolescents and found that most participants exhibited moderate levels of resilience, emphasizing that resilience is influenced by environmental support systems, family relationships, and intervention programs rather than individual characteristics alone.

Moreover, it was hypothesized that there exists a significant correlation amongst Emotional stability and Resilience. For this mean and SD were computed. The results are displayed in table no. 3:

Table No. 3:
Mean and SD of Emotional Stability and Resilience

	Emotional Stability	Resilience
Mean	23.7	136.4
SD	7.8	7.1

It can be seen from above table that the data is normally distributed. The mean score of 23.7 on Emotional Stability suggests that the adolescents, on average, exhibited low emotional stability, indicating difficulties in maintaining emotional balance and coping effectively with stress. The mean score of 136.4 on Resilience suggests a moderate level of resilience, indicating that the adolescents possessed some capacity to adapt to challenges. Further, to analyse the relationship between the variables the data was subjected to coefficient of correlation. The results are displayed in table no. 4

Table No. 4
Coefficient of correlation between Emotional Stability and Resilience

Category	r	Correlation
Adolescents	0.16	Positive but weak

Table no. 4 reveals that the value of r is 0.16. Though correlation between both the variables: Emotional Stability and Resilience is positive but it is weak. Thus, it can be stated that the hypothesis framed "there exists significant relation between Emotional Stability and Resilience among adolescents" is rejected".

The present study revealed a **positive but weak correlation (r = 0.16)** between emotional stability and resilience among adolescents. This indicates that although emotionally stable adolescents tend to exhibit greater resilience, the relationship is not strong enough to suggest that emotional stability is the sole determinant of resilience. Resilience is a multidimensional construct influenced by several internal and external factors such as family support, peer relationships, coping strategies, self-esteem, optimism, socio-economic status, life experiences, and academic environment. Therefore, adolescents with relatively low emotional stability may still demonstrate resilience if they receive adequate social and emotional support or possess effective coping skills.

Furthermore, adolescence is a developmental period characterized by rapid physical, emotional, cognitive, and social changes. Temporary emotional fluctuations are common during this stage and may reduce the strength of the association between emotional stability and resilience. Individual differences in personality, exposure to stressors, and environmental resources may also contribute to the weak correlation observed in the study.

Conclusion: From the statistical interpretation of the data the following conclusion were drawn:-

1. Low levels of Emotional Stability were exhibited from adolescents.
2. 70% of adolescents showed moderately low to low level of Resilience.
3. Emotional Stability and Resilience though positively related; the relationship is weak.

Recommendations:

1. It is recommended that colleges should organize series of guest lectures on topics such as how to develop emotional stability and resilience and motivation etc.
2. Adolescents should be motivated and guided to be physically and mentally fit by following regular and healthy life style.

Suggestion:

1. Large sample can give big results
2. Correlation between Personality Factors and Resilience can yield interesting results.

Limitations:

1. The sample size was limited to 60 only.
2. Gender differences were not studied.

REFERENCES :

Books:

- Costa, P. T., Jr., & McCrae, R. R. (1985). NEO Personality Inventory Manual. Odessa, FL: Psychological Assessment Resources.
- Wagnild G.M. (2009) The Resilience Scale User's Guide for the US English version of the Resilience Scale.

Journal article on internet:

- Alhajri, R., Naomie, Castor, & Elmassioui, F. (2000). The impact of parental treatment on resilience in adolescents. JESS (Journal of Education on Social Science). Retrieved from https://www.researchgate.net/publication/348501378_THE_IMPACT_OF_PARENTAL_TREATMENT_ON_RESILIENCE_IN_ADOLESCENTS
- Bajaj, B., Gupta, R.& Sengupta, S. (2019). Emotional Stability and Self Esteem as Mediators Between Mindfulness and Happiness. Journal of Happiness Studies. 20. 10.1007/s10902-018-0046-4. Retrieved from https://www.researchgate.net/publication/328390558_Emotional_Stability_and_SelfEsteem_as_Mediators_Between_Mindfulness_and_Happiness.
- Chaturvedi, M., &Chander, R. (2010). Development of Emotional Stability Scale. Industrial Psychiatry Journal, 19(1), 37-40. Retrieved from https://doi.org/10.4103/0972-6748.77634
- Choudhary, S. (2019). Emotional intelligence and resilience among adolescents. 8 1-10. Retrieved from https://www.researchgate.net/publication/333237570_EMOTIONAL_INTELLIGENCE_AND_RESILIENCY_AMONG_ADOLESCENTS
- Connor, K. M., & Davidson, J. R. T. (2003). Development of a new resilience scale: The Connor-Davidson Resilience Scale (CD-RISC). Depression and Anxiety, 18(2), 76–82.
- Khuraijam, K. (2024). Emotional stability amongst adolescent students: A comparative study of boys and girls in Manipur. Library Progress International, 44(3), 20109–20115. https://doi.org/10.48165/bapas.2024.44.2.1
- Ledesma, J. (2014). Conceptual frameworks and research models on resilience in leadership. SAGE Open, 4(3), 1–8.
- Luthans, F. (2002). Positive organizational behaviour: Developing and managing psychological strengths. Academy of Management Executive, 16(1), 57–72.

- Mary. E, Manchula; Patra Swati (2015). Relationship between Forgiveness, Gratitude and Resilience among the Adolescents. Indian Journal of Positive Psychology, 6(1). Retrieved from https://www.ischolar.in
- McCrae, R. R., & Costa, P. T., Jr. (2007). Brief versions of the NEO-PI-3. Journal of Individual Differences, 28, 116-128.
- Shetty, V. (2020). Resilience, Emotional Stability and Perceived Stress Among 10th Graders. Investigates The Relationship Between Resilience, Emotional Stability and Perceived Stress. Indian Journal of Mental Health, 6(2). Retrieved from https://www.researchgate.net/publication/341965710_Resilience_Emotional_Stability_and_Perceived_Stress_among_10th_Graders
- Sharma, S. (2020) Emotional Stability of Day Scholars and Boarders Adolescent Boys: A Study. Asian Journal of Education and Social Studies. 26-31. 10.9734/ajess/2020/v11i430298. Retrieved from https//www.researchgate.net/publication/346368880_Emotional_Stability_of_Day_Scholar_and_Boarders_Adolescent_Boys_A_Study
- Smithson, W. D. (1974). Psychology of human adjustment: Principles of mental health. New York, NY: McGraw-Hill.
- Southwick, S. M., Bonanno, G. A., Masten, A. S., Panter-Brick, C., &Yehuda, R. (2014). Resilience definitions, theory, and challenges: interdisciplinary perspectives journal of psych traumatology, 5, 10.3402/ejpt. v5.25338.
- Thorndike, R. L., & Hagen, E. P. (1969). Measurement and evaluation in psychology and education (3rd ed.). New York, NY: John Wiley & Sons.

A Review on Emerging Paradigms in Electric Vehicle Charging Monitoring and Integrated Fire Protection System

U. Bhandekar, M. Lute, A. Bashir, N. Nellore, N. Saklani

Department of Applied Electronics & Software Technology,
Gurunanak Institute of Engineering and Technology, Nagpur

Abstract

The rapid global transition from internal combustion engine (ICE) vehicles to electric vehicles (EVs) has necessitated a revolutionary shift in how energy infrastructure is monitored and protected. Central to this transition is the lithium-ion battery (LIB), a technology prized for its high energy density and efficiency but fraught with inherent chemical risks, most notably thermal runaway. As charging speeds increase and high-power DC fast charging (DCFC) stations become ubiquitous, the electrical and thermal stresses on both vehicle and infrastructure intensify, demanding sophisticated monitoring systems that can anticipate failure rather than merely react to it. Modern safety frameworks are now converging toward an integrated architecture that combines Internet of Things (IoT) sensors, edge computing, machine learning, and advanced chemical suppression agents to create a resilient defense-in-depth strategy.

Keywords : Semiconductor Manufacturing , Electronic Design Automation (EDA) , Wafer Defect Detection , Graph Neural Networks (GNN), Reinforcement Learning (RL)

1. Introduction:

The global transition toward electric vehicles (EVs) has fundamentally altered the landscape of energy infrastructure, placing lithium-ion batteries (LIBs) at the core of modern transportation. While highly efficient, LIBs pose significant human safety and infrastructure hazards due to the inherent risk of thermal runaway—an uncontrollable, self-heating state that can result in fires and explosions. Research indicates that the majority of fire-related incidents occur during the battery's charge cycle, specifically when the state of charge (SoC) is elevated.

The causes of these incidents are multifaceted, ranging from electrical abuse, such as overcharging and faulty Battery Management Systems (BMS), to physical damage and manufacturing defects. As the industry moves toward high-power DC fast charging (DCFC) stations with potentials ranging from 400 to 1,000 volts, the electrical and thermal stresses on both the vehicle and the charging infrastructure intensify. Existing charging systems often lack real-time monitoring and autonomous fault detection, making it challenging to prevent incidents before they escalate into catastrophic failures. To address these vulnerabilities, modern safety frameworks are shifting toward an integrated monitoring and fire protection architecture. These systems utilize Internet of Things (IoT) sensors to track critical parameters such as temperature, current, and the release of precursor gases like hydrogen and carbon monoxide. Furthermore, machine learning (ML) models are increasingly employed to analyze real-time telemetry and predict thermal runaway events with high accuracy. When detection occurs, a coordinated response is required, involving automatic emergency power disconnection and the activation of specialized suppression agents—such as FK-5 clean agents or F-500 EA encapsulator mists—which are uniquely suited for high-energy electrical fires. This paper explores the emerging technologies, regulatory standards, and system architectures necessary to build a resilient and safe EV charging network.

2. Review Methodology

To ensure a systematic and rigorous evaluation of the literature concerning EV charging safety, monitoring architectures, and fire mitigation, a structured review methodology was adopted.

- **Database Selection:** Comprehensive literature searches were conducted across major academic databases, including IEEE Xplore, Scopus, Web of Science, and ScienceDirect.
- **Search Keywords:** Search strings incorporated terms such as "Electric Vehicle charging safety", "lithium-ion battery thermal runaway", "IoT sensor fusion BMS", "machine learning anomaly detection fire safety", and "fire suppression agents for EV fires".
- **Inclusion and Exclusion Criteria:** Peer-reviewed journal articles, conference papers, and technical standards published primarily between 2022 and 2026 were prioritized to capture state-of-the-art technological advancements. Studies lacking empirical validation or engineering implementation details were excluded.
- **Selection Yield:** A total of over 45 foundational and recent articles were evaluated to synthesize the qualitative and comparative insights presented in this review.

3. Electrochemical Dynamics and the Kinetics of Thermal Runaway

Understanding the monitoring requirements of an EV charging station begins with the fundamental electrochemistry of the lithium-ion cell. A lithium-ion battery operates through the movement of lithium ions between a cathode and an anode through an electrolyte and a porous separator. During the charging phase, ions move toward the anode, where they are intercalated into the host material. However, if the rate of charging is too high, or if the battery is subjected to overvoltage, the system can enter a state of instability. Thermal runaway is the most critical failure mode, characterized by a self-sustaining exothermic reaction where the heat generated by internal chemical processes exceeds the rate at which it can be dissipated.

This phenomenon typically initiates with the decomposition of the Solid Electrolyte Interphase (SEI) layer at temperatures between 90°C and 120°C. The SEI layer is a passivation layer formed during the battery's first cycles; its breakdown allows the electrolyte to react directly with the lithiated anode, releasing significant thermal energy and flammable gases. As internal temperatures continue to climb, the separator, often composed of polyethylene or polypropylene, begins to melt. This leads to internal short circuits, which provide a low-resistance path for the stored chemical energy to discharge instantaneously, further accelerating the temperature rise. The final and most violent stage of thermal runaway involves the decomposition of the cathode material, which releases oxygen. This oxygen fuels the combustion of the flammable electrolyte vapors, often resulting in jet flames, explosions, and the release of toxic aerosols.

Comparative Thermal Stability of Battery Chemistries

The chemical composition of the battery significantly influences its thermal runaway behavior and, consequently, the monitoring strategy required. While Lithium Nickel Manganese Cobalt Oxide (NCM) batteries offer higher energy density, they generally exhibit lower thermal stability than Lithium Iron Phosphate (LFP) batteries.

Table I : Comparison of NCM811 and LFP Chemistry Gas Emissions and Failure Characteristics

Feature	NCM811 Chemistry	LFP Chemistry
Primary Decomposition Gas	Carbon Monoxide (CO) ~49%	Hydrogen (H_2) ~36%
Secondary Gas Component	Hydrogen (H_2) ~25%	Carbon Dioxide (CO_2) ~25%
Thermal Runaway Onset	Lower Temperature Threshold	Higher Temperature Threshold
Oxygen Release	High (Internal Cathode Decomposition)	Minimal (Higher Structural Stability)
Specific Hazard	Rapid propagation and high heat	Lower propagation but significant gas release

The gaseous emission profile during failure serves as a critical telemetry point for monitoring systems. In NCM batteries, the high concentration of "CO" (49.26%) and "H" _2 (25.06%) necessitates sensors capable of high-sensitivity detection of these specific markers. Conversely, LFP systems, which dominate the energy storage and public transport sectors due to their longevity, primarily release "H" _2 (36.34%) and 〖"CO" 〗_2 (25.24%) during failure, requiring a different sensor calibration for early warning.

4. Mechanisms of Failure during the Charging Cycle

Research into battery safety highlights that the majority of fire-related incidents involving lithium-ion batteries occur during the charge cycle or shortly thereafter, when the battery's state of charge (SoC) is elevated. This risk is compounded by various forms of abuse, including electrical, thermal, and operational factors.

Electrical Abuse and the Overcharge Phenomenon

Overcharging is identified as the most severe failure mechanism during the charging process. It occurs when the charging current continues to flow after the battery has reached its maximum voltage limit, often due to a failure in the Battery Management System (BMS) or an incompatibility between the charger and the vehicle. When a cell is overcharged, lithium ions that cannot be intercalated into the anode host material instead plate onto the surface of the anode as metallic lithium. This "lithium plating" can form dendrites—microscopic needle-like structures—that can eventually penetrate the separator and cause an internal short circuit. Experimental data shows that when a battery is overcharged to 143% SoC, the temperature required to initiate thermal runaway drops from 140°C to 60°C, drastically narrowing the safety margin. In e-scooter testing, thermal runaway induced by intentional overcharge resulted in jet flames extending 6 to 7 feet above the battery pack, with ignition occurring as quickly as 13 seconds after the first sign of visible smoke.

Mechanical and Environmental Factors

Beyond electrical faults, external factors can also compromise charging safety. Mechanical abuse, such as physical damage to the battery pack or

the charging cable, can create short circuits. Thermal abuse, caused by high ambient temperatures or inadequate ventilation in the charging area, can lead to localized overheating. Furthermore, aging batteries—those with a reduced State of Health (SoH)—exhibit poorer stability and higher mass loss rates during failure, suggesting that monitoring systems must adapt to the aging profile of the vehicle fleet.

5. Intelligent Monitoring Architecture: Edge to Cloud

To effectively manage these risks, contemporary EV charging infrastructure employs a multi-tiered monitoring architecture. This framework integrates the perception of physical parameters at the station level with high-level data processing and remote management capabilities.

The Perception Layer and Sensor Fusion

The perception layer is the frontline of the monitoring system, consisting of a suite of sensors designed to detect the physical and chemical indicators of failure. High-fidelity monitoring requires more than just temperature sensing; it demands a "sensor fusion" approach where multiple data streams are correlated to confirm an anomaly.

Table II: Sensor Fusion Parameters and Safety Roles in EV Charging Stations

Sensor Type	Monitored Parameter	Role in Safety
Thermistor/DS18B20	Cell and ambient temperature	Detects overheating and rapid temperature rise
Shunt/Hall Effect	Charging current and voltage	Identifies overcharging and electrical anomalies
MEMS Pressure Sensor	Internal enclosure pressure	Detects cell venting before ignition
MOS Gas Sensor	CO, H_2, and electrolyte vapors	Provides the earliest warning of internal failure
Aerosol Sensor	Particulate matter and smoke	Detects liquid droplets and smoke from thermal events
Image Sensor/Camera	Visual flame and smoke patterns	Real-time verification of fire for emergency response

The integration of gas sensors is particularly vital for early detection. Before thermal runaway leads to a fire, cells undergo off-gassing, where internal pressure forces the release of electrolyte vapors (such as DEC and DMC). Detection of these vapors can provide an early warning of several minutes—often referred to as the "golden time" for intervention—before a fire or explosion occurs.

Edge Computing and Local Control

Given the speed at which thermal runaway can escalate, relying solely on cloud-based processing is insufficient due to latency issues. Edge computing facilitates the processing of high-frequency sensor data locally at the

charging station. Edge controllers, such as those based on the Arduino Uno, Raspberry Pi Pico, or ESP32, can implement real-time filtering algorithms to minimize noise and fluctuations in sensor readings. These local systems are programmed with "fail-safe" logic. If a critical threshold is met—for instance, if the battery temperature exceeds 60°C or if the rate of temperature change exceeds 0.5°C per 30 seconds—the edge controller can immediately trigger a relay to disconnect the charging power, activate local alarms, and signal the fire suppression system.

Cloud Integration and Communication Protocols

The third tier of the architecture is the cloud-based Charging Station Management System (CSMS). Communication between the charging station and the CSMS is primarily handled through the Open Charge Point Protocol (OCPP), which allows for standardized message exchange across different hardware manufacturers. MQTT (Message Queuing Telemetry Transport) has become the preferred protocol for IoT-based charging monitoring due to its lightweight nature and efficiency in distributed networks. MQTT allows the CSMS to monitor grid load and dynamically optimize energy distribution, a process known as Smart Charging. This capability is essential for balancing the network and preventing overloading during peak periods, which itself is a safety measure to prevent transformer failure or grid instability.

6. Advanced Machine Learning and Artificial Intelligence in Predictive Fire Safety

As the volume of data collected from charging stations grows, machine learning (ML) and advanced artificial intelligence are being leveraged to transition from reactive threshold-based alarms to predictive safety models.

Classical ML vs. Deep Learning Models

- **Logistic Regression:** Provides probability estimates of thermal runaway occurrences by evaluating the relationship between temperature, SoC, and voltage.
- **Support Vector Machines (SVM):** Effective at identifying complex, non-linear patterns in high-dimensional sensor data, distinguishing between normal heat generation and dangerous thermal excursions.
- **Random Forest and XGBoost:** Ensemble learning methods that handle tabular multi-sensor streams robustly, minimizing false positive rates during high transient loads.
- **Long Short-Term Memory (LSTM) and Gated Recurrent Units (GRU):** Recurrent neural networks capable of modeling time-series degradation, capturing slow thermal accumulation patterns leading up to battery failure.
- **Convolutional Neural Networks (CNN) & Transformers:** Applied to spatial-temporal sensor grids and advanced computer vision streams to model multi-channel interactions over time.

Explainable AI (XAI) and Computer Vision

High recall is critical in fire safety applications to ensure that all true positive instances of thermal runaway are flagged. To build operator trust, Explainable AI (XAI) frameworks are integrated to render black-box neural network decisions interpretable by highlighting which specific feature contributions (e.g., sudden voltage sag paired with gas release) triggered an alert. Furthermore, in high-density environments like parking garages, vision-based fire detection complements internal battery sensors. Improved versions of the YOLOv4 deep learning model demonstrate a detection speed of 43 frames per second (fps) and a mean Average Precision (mAP) of 91.53%, detecting incipient flames and smoke early.

7. Comparative Analysis of Fire Protection and Suppression Technologies

When fire suppression is triggered, selecting the correct medium is vital to prevent electrical hazards and collateral damage.

Table III: Comparison of Fire Suppressants for EV Charging Infrastructure

Suppressant Medium	Electrical Safety	Cooling Efficacy	Residue Profile	Primary Application
Water Mist	Moderate (Depends on conductivity)	High	High Water Damage	Open-air and large bays
Aerosol Suppression	Non-conductive	Moderate	Minimal Powder Trace	Enclosed battery compartments
FK-5-1-12 Clean Agent	Highly Non-Conductive	Moderate	Zero Residue	Control kiosks and power electronics
F-500 EA Encapsulator	Non-Conductive when mixed	Extremely High	Low Chemical Residue	Direct battery pack suppression
CO_2 **/ Inert Gases**	Non-Conductive	Low to Moderate	Zero Residue	Sealed electrical rooms

- **F-500 EA Encapsulator Technology:** Works by changing the composition of a water droplet through the introduction of spherical micelles. These micelles encapsulate flammable gases and electrolyte vapors, scrubbing toxins while providing cooling significantly faster than plain water. It reduces ambient temperatures from over 2,000°F down to safe levels before steel-reinforced concrete or structural elements reach failure points (such as 600°C).
- **FK-5-1-12 Clean Agent Systems:** Preferred in areas containing sensitive electronic equipment (power converters and control boards) because they are non-conductive, leave no residue, and rapidly flood confined inverter enclosures.

8. Regulatory Standards and Compliance Frameworks

Compliance with international and national safety standards is mandatory for commercial operation and grid integration of EV charging hubs. Key standards governing infrastructure and battery safety include:

- **Electrical Safety & Installation:** IEC 61851 (EV conductive charging system requirements), IEC 62196 (Plugs, socket-outlets, and vehicle connectors), and NFPA 70 (National Electrical Code).
- **Protection & Residual Current Devices:** IEC 62955 (RCDs for DC EV charging stations).
- **Energy Storage & Fire Safety Systems:** UL 9540 / UL 9540A (Battery energy storage

system safety and fire propagation evaluation), NFPA 855 (Standard for the Installation of Stationary Energy Storage Systems), and ISO 6469 (Electric road vehicle safety specifications).

- **Local Regional Standards:** India's AIS-156 amendments for battery safety and electrical powertrain performance.

9. Infrastructure Design and Hardware Components

The physical design of an EV charging station must incorporate several layers of electrical and physical protection to ensure safety during high-power operations.

Electrical Distribution and Safety Devices

A robust charging station requires a dedicated transformer and substation equipment. Mandatory protection devices within the charging pile include:

- **Residual Current Devices (RCDs):** Essential for mitigating electric shock risk by detecting leakage currents as low as 30mA.
- **Surge Protection Devices (SPDs):** Protect the station and connected vehicle from voltage spikes caused by lightning or grid switching.
- **Arc Fault Detection Devices (AFDDs):** Detect the unique signature of an electrical arc, serving as an electrical fire precursor.
- **Isolation Transformers:** Ensure that the high-voltage DC side of the charger is electrically isolated from the AC grid.

Hardware Integration for Monitoring

The hardware core typically includes a high-speed microcontroller (such as an Arduino or TI C2000 real-time MCU) interfaced with precision analog-to-digital converters (ADCs). These MCUs manage the "handshake" between the station and the vehicle via the Control Pilot (CP) pin. Continuous monitoring of this signal with a tolerance of ±2% is crucial; any deviation signals a communication failure or electrical anomaly, triggering an immediate shutdown.

10. BMS and Facility Fire Panel Integration

In commercial and residential facilities, the EV charging monitoring system must integrate with the broader Building Management System (BMS) and the Fire Alarm Control Panel (FACP).

System Handshake and Emergency Protocols

When an anomaly is detected, a coordinated facility-wide response occurs:

1. **Detection and Signal:** The charging station's local controller signals the FACP via dry contacts or protocols like BACnet or Modbus.
2. **Power Isolation:** The BMS immediately commands the main circuit breaker for the charging zone to trip, isolating the electrical source.
3. **HVAC and Smoke Control:** Fire dampers in the ventilation system close to prevent smoke migration, and high-capacity exhaust fans activate to remove toxic gases.
4. **Suppression Activation:** Localized suppression (such as Stat-X or F-500 EA mist) is deployed to contain the fire.
5. **Evacuation and Access:** Emergency lighting activates, security barriers open for emergency personnel, and elevators recall to safe floors.

Challenges in High-Density Parking

Underground and multi-level parking structures present severe fire protection challenges due to closely parked vehicles and confined ventilation. Automatic detection and suppression are baseline necessities here, coupled with fire-rated compartmentation and strategic placement of charging stalls near structural exits.

11. Discussion and Future Research Directions

Synthesizing current literature reveals that while component-level BMS monitoring has matured,

system-level harmonization across grid operators, cloud platforms, and local fire panels remains challenging.

Critical Technological Limitations and Research Gaps

- **Cybersecurity Vulnerabilities:** As charging stations rely heavily on IoT communication protocols (MQTT, OCPP), they become targets for cyber-attacks that could maliciously manipulate charging profiles or disable thermal cutoffs.
- **Digital Twin Integration:** Real-time synchronization of physical battery aging states with cloud-based Digital Twins remains computationally expensive for edge implementation.
- **Vehicle-to-Grid (V2G) Bi-directional Safety:** Bi-directional power flow introduces complex reverse-current failure modes that current protection architectures are only partially equipped to handle.
- **Federated Learning for Privacy-Preserving AI:** Training predictive ML models across distributed charging networks without violating proprietary user and vehicle telemetry privacy is an ongoing challenge.

12. Operational Best Practices and Maintenance

Maintaining safety across EV charging infrastructure requires a structured maintenance regime:

- **Regular Inspections:** Perform visual and thermal inspections of cables, connectors, and enclosures to identify wear, mechanical damage, or overheating.
- **Firmware Updates:** Regularly patch smart chargers to eliminate security vulnerabilities and refine diagnostic algorithms.
- **Grounding and Earthing:** Verify earthing system integrity to ensure proper shock protection and correct RCD operation.
- **Housekeeping:** Keep charging bays free of combustible materials to maintain unobstructed firefighter access.

13. Conclusion

The integration of advanced monitoring and fire protection systems is essential for the safe and scalable deployment of electric vehicle charging infrastructure. Safety is achieved through a multi-layered defense strategy spanning cell-level BMS tracking, station-level perception, and facility-wide BMS coordination. The adoption of IoT, edge computing, and machine learning delivers rapid early warning capabilities, while modern suppression agents like F-500 EA encapsulators provide the necessary mitigation for high-energy fires. As regulatory standards like AIS-156, IEC protocols, and NFPA requirements evolve, the industry moves toward a resilient future capable of withstanding the complex chemical challenges of electro-mobility.

REFERENCES :

- Mastanamma, Y., Laxman, B., Archana, A., & Pulla Reddy, K. “EV BMS With Charge Monitor and Fire Detection.” E3S Web of Conferences, 472, 03006, 2024.
- Zhang, S., Yang, Q., Gao, Y., & Gao, D. “Real-Time Fire Detection Method for Electric Vehicle Charging Stations Based on Machine Vision.” World Electric Vehicle Journal, 13(2), 23, 2022.
- P. Gopinathan, M. Sasikaran, M. Vaishya, M. Saikrishna & D. Sakthivel. “Design and Implementation of IoT-Based Charger Monitoring and Fire Protection for EV System.” IJSART, Vol. 11, Issue 5, 2025.
- “EV BMS Fire Protection and Charge Monitoring.” International Journal of Information Technology and Computer Engineering, Vol. 13, No. 3, 2025.
- Sonam Pawar, Shravani Mitkari & Shilpa Kodgire. “Battery Management System and Fire Protection in EVs.” Journal of Control

Systems and Converters, 2025.

- Verma, A., Kumar, S., Tiwari, N., Kumar, R., Gupta, V., & Ansari, M. S., "BMS with Charge Monitor and Fire Protection in EV Based on IoT." International Journal of All Research Education & Scientific Methods, 2025.
- Alam, M. M., Jagli, P., Ayman, M., & Akhtar, M. J. "Electric Vehicle Battery Management System with Charge Monitor and Fire Protection." International Education and Research Journal (IERJ), 2024.
- "Electric Vehicle Battery Management System with Charge Monitor and Fire Protection." International Research Journal of Modernization in Engineering Technology and Science, 2026.

Causes and Consequences of Workplace Stress among Teachers

Ms. Rashmi Kochey

Asst. Professor, Family resource department, L. A. D. College

Abstract

Teaching is recognized as one of the most high-stress professions globally. Workplace stress in this context is defined as a teacher's experience of negative emotions—such as anger, anxiety, and frustration—resulting from aspects of their professional role. While stress is a common workplace phenomenon, in education it has reached critical levels. The present study was conducted in various schools of Nagpur city. Purposive Sampling was used to select the samples. Survey method was used to collect data which comprised of 100 samples. Questionnaire method was the tool used to collect data which was further analysed with the help of percentages. In conclusion, workplace stress greatly affects teachers' health, job satisfaction, and teaching quality. Proper support, balanced workload, and healthy stress management practices can help reduce stress and improve both teacher well-being and students' learning outcomes.

Key words: Teachers, Workplace stress, Job Satisfaction

Introduction : Work place stress has become a significant issue in the teaching profession due to increasing work load, administrative responsibility, and changing educational demand. Teachers are expected to perform multiple roles beyond classroom instructions which often lead to physical, emotional and psychological strain. Workplace stress in the teaching profession has escalated into a global public health and educational crisis. As of 2026, teaching remains one of the most high-pressure professions, frequently recording higher rates of burnout and emotional exhaustion than other high-intensity fields like healthcare. Occupational stress in this sector occurs when the relentless demands of the classroom and administrative requirements far exceed a teacher's available resources and coping mechanisms. This "helper's burden" is exacerbated by the fact that many educators now serve as de facto social workers and counselors, leading to a state of chronic fatigue that negatively impacts their mental health and, by extension, the quality of education provided to students.

The primary drivers of this stress are multifaceted, ranging from systemic workload issues to the emotional labor of classroom management. Research indicates that teachers often spend less than thirty percent of their workday on actual instruction, with the remainder consumed by grading, curriculum updates, and a heavy administrative burden. Beyond these logistical hurdles, managing diverse student behaviors and supporting the complex social-emotional needs of children requires a constant level of emotional regulation that rapidly depletes mental energy. The consequences of unmanaged teacher stress extend far beyond individual wellness, creating a ripple effect that compromises the entire educational ecosystem. When teachers suffer from chronic stress, instructional quality inevitably declines, and student motivation wanes. On a personal level, teachers face severe physical and psychological risks, including chronic headaches, sleep disturbances, anxiety, and depression, which often lead to premature departure from the profession.

Addressing this crisis requires a holistic strategy that combines individual psychological support with systemic institutional reform. Evidence-based interventions such as Mindfulness-Based Stress Reduction and Cognitive-Behavioral Therapy have proven effective in helping teachers manage their internal responses to stress

and improve their overall resilience. However, individual coping strategies are insufficient without administrative changes that address the root causes of the problem. This includes delegating non-instructional tasks to support staff, fostering more collaborative peer environments, and prioritizing educator well-being as a core metric of school success. By shifting toward more student-centered instruction and supportive leadership models, educational institutions can create a more sustainable environment where both teachers and students have the opportunity to thrive

The landscape of these stressors has also been reshaped by rapid technological shifts and significant demographic disparities. While the integration of artificial intelligence and game-based learning holds the potential to save hundreds of hours in lesson planning, the pressure to master these complex new tools without adequate training time has paradoxically increased cognitive load for many. Furthermore, the burden of this stress is not distributed equally; female educators report feeling overwhelmed at a significantly higher rate than their male counterparts, often due to the "double burden" of balancing domestic responsibilities with an increasingly demanding professional role. This gender gap, combined with the struggles of early-career teachers who often lack robust mentorship, has made the profession particularly vulnerable to high attrition rates in recent years.

Solving this complex issue requires moving beyond basic self-care advice toward a multi-layered intervention framework that prioritizes organizational change. Effective strategies now include institutional "tap out" policies that allow for brief mental health breaks during the school day and strict boundaries on after-hours digital communication to prevent burnout. On a psychological level, targeted training in emotion regulation and rational emotive behavior therapy has proven far more effective than general wellness programs in helping teachers navigate the daily emotional demands of the classroom. By fostering strong peer support networks and involving educators in workload monitoring, schools can begin to dismantle the isolation that often precedes burnout, creating a more resilient and sustainable educational system for both teachers and their students.

2. Review of Literature:

Stress and burnout among teachers can negatively impact their capacity to perform job functions, productivity and their ability to build positive relationships related to their role. This is an important global problem, given the connection between stress and burnout and the subsequent development of anxiety and depression among teachers, as highlighted in a recent scoping review. Thus, interventions designed to reduce stress response, burnout, associated negative beliefs and other aspects of functioning may be essential to reducing teachers' anxiety and depression. Identifying effective interventions for addressing stress and burnout among teachers is a vital initial step in dealing with this global problem. This scoping review identified 40 studies examining interventions to reduce or mitigate teachers' stress and burnout. Moreover, effective coping, which may be improved during such programs, is an instrumental skill set that ultimately benefits the teachers' role. Although most interventions intended to reduce teachers' stress and burnout have had limited success, this scoping review found that some interventions can potentially address stress and burnout among teachers.

2. The education sector plays a vital role in society, with teachers serving as its backbone. As highlighted in this literature review, teachers often face significant stress, which negatively impact both their personal health and organizational productivity. Stress has been noted to be rising distressingly among teachers, reflecting more work and less reward for our teachers

3. The majority of teachers in our study were

showing mild occupational stress, followed by moderate and then severe occupational stress. The teachers stated vast syllabus and shortage of time to cover the portions, interference from outside and student's behaviour, poor infrastructure and favourism from authorities as some of the reasons for their stress. For reducing occupational stress teachers suggested reduction in portion, co-operation among staffs, good infrastructure, healthy lifestyle and stress releasing exercises.

Objectives of the study:

1. To identify the key factors contributing to workplace stress among teachers.
2. To analyse the impact of workload, role conflict, and time pressure on teacher's stress level.
3. To find out the consequences of workplace stress on teacher's physical and psychological health, job performance and job satisfaction.
4. To find out remedies and solutions of workplace stress.

Hypothesis:

It is assumed the Teachers of various schools of Nagpur city are facing workplace stress, which in turn is affecting their job performance.

Need and importance of the study:

1. Improves teacher's health
2. Better teaching quality
3. Increases job satisfaction
4. Reduce burnout
5. Improves student's performance
6. Helps school administration
7. Encourage positive workplace environment
8. Supports professional growth

3. Research Methodology

The present study was conducted in various schools (public school and private school both) of Nagpur city. Purposive Sampling was used to select the samples. Survey method was used to collect data which comprised of 100 samples. Questionnaire method was the tool used to collect data which was further analysed with the help of percentages.

Results and Discussion

Characteristics of the Respondents:

Maximum respondents were found out to be of 30-40 years of age (56%). Are post graduate with B.Ed (64%). And are staying in Joint family (45%). Maximum respondents are earning an income of 20 thousand and above (48%)

Table No: 1
Key factors contributing to workplace stress among teachers. **N=100**

Sr. No.	Option	Nimber	Percentage
1	Heavy work load	85	85%
2	Time pressure	80	80%
3	Student's behaviour	76	76%
4	Lack of resources	45	45%
5	Low salary and other material benefits	40	40%
6	Pressure from higher authorities	87	87%
7	Parental expectations	88	88%
8	Work-life balance	78	78%
9	Workplace relationship	82	82%
10	Job insecurity	56	56%

• Multiple responces

It can be seen from Table No1, that 85% of respondents are facing problem of heavy workload, 80% of them are having issue of time pressure, they cannot fulfil the required amount of work in the given time. 76% of respondents are facing an issue of misbehaviour of students. For 45% of respondents sufficient resources are not made available by their institutions. 40% respondents say that they get low salary and compared to their work and do not receive any other material benefit from their institutions. With a maximum of 87% respondents say that they face a lot of stress if their higher authorities and management creates pressure on them. 88% respondents say that they face pressure and expectations from their student's parents. 78% is facing stress in managing their own home and workplace. For 82% respondents their work place relationship is also creating stress for them. And 56% are having job insecurity.

Workplace stress greatly affects teacher's mental health, job satisfaction and teaching quality. Managing work load properly is important for maintaining effective education and teacher's well being.

Table no: 2
Impact of workplace stress on respondents **N=100**

Sr. No.	Option	Nimber	Percentage
1	Mental stress and anxiety	85	85%
2	Physical Fatigue	67	67%
3	Reduced teaching efficiency	86	86%
4	Burnout	90	90%
5	Absenteeism	46	46%

It can be seen from table no 2 that 85% of respondents feel mental stress and become anxious in their workplace. 67% feel physical fatigue and are drain after their work hours. For 86% respondents their teaching is greatly affected because of workplace stress. 90% respondents feel burnout because of stress and 46% of them say that they purposefully remain absent form their work because of their work place stress.

Solutions and suggestions from teachers:

Teachers believe that workplace stress can be reduced through proper time management, healthy work habits, and support from the school administration. Many teachers feel that planning daily activities and maintaining a balance between professional and personal life helps them handle pressure more effectively. They also believe that support from colleagues, parents, and school authorities creates a positive working environment. Teachers often use stress management techniques such as exercise, yoga, meditation, and hobbies to relax and maintain mental health. Improving teaching skills through training and workshops also increases confidence and reduces work-related anxiety. Teachers further feel that recognition for their hard work, reasonable workload, regular breaks, and open communication with management are important remedies for reducing workplace stress and improving job satisfaction.

Recommendations:

Teachers' workplace stress can also be reduced by creating a friendly and respectful school environment where teachers feel valued and heard. Schools should encourage teamwork and cooperation among staff members so that teachers do not feel isolated in handling responsibilities. Providing flexible schedules, reducing unnecessary paperwork, and ensuring

fair distribution of duties can further lower stress levels. Regular motivational programs, recreational activities, and mental health awareness sessions can help teachers stay positive and emotionally strong. Teachers should also be encouraged to take adequate rest, maintain healthy social relationships, and seek professional counseling whenever needed. In general, a supportive atmosphere, proper communication, and attention to teachers' well-being are essential for reducing workplace stress and improving the quality of education.

Conclusion:

Workplace stress is a major issue affecting teachers' mental health, physical well-being, job satisfaction, and teaching performance. Factors such as heavy workload, time pressure, student behavior problems, lack of resources, and administrative demands increase stress among teachers. If not managed properly, stress can lead to burnout, poor work performance, and negative effects on students' learning. Therefore, it is important for schools, administrators, parents, and teachers themselves to work together to reduce workplace stress. Supportive management, balanced workload, healthy work-life balance, stress management techniques, and positive workplace relationships can help teachers perform effectively and maintain their well-being. Reducing teachers' workplace stress ultimately improves the quality of education and creates a better learning environment for students.

REFERENCES:

- Interventions to Reduce Stress and Burnout among Teachers: A Scoping Review
- Belinda Agyapong 1,*, Pamela Brett-MacLean 1, Lisa Burback 1, Vincent Israel Opoku Agyapong 1,2, Yifeng Wei 1
- Editors: Adam Hege, Brian Whitaker, Michael Kenneth Lemke
- Work Stress among School Teachers: A Systematic Literature Review
- Kavitha B., Jacinta V. May 2025, Social Medicine 18(2):110-117
- OI:10.71164/socialmedicine.v18i2.2025.1869
- A Cross sectional study to estimate occupational stress among higher secondary school teachers in kerala, Krishna Raj et. Al.
- https://www.researchgate.net/publication/358557957_A_cross-sectional_study_to_estimate_occupational_stress_among_higher_secondary_school_teachers_in_Thalassery_Kerala

Aggressive Behavior in Adolescents: Role of Gender and Board of Education

Ms. Reema Siddhu*

*Research Scholar, Dept. of Human Development,
L.A.D. and Smt. R.P. College for Women, Nagpur

Abstract

Aggressive behavior is one of the problems which might have an adverse effect on adolescents, especially on their development progression. This study aims to understand the effect of gender and board of education on aggressive behavior in adolescents. The participants of the study were 200 school students aged 14-16 years. The tool used was the Aggression Scale by Dr. G. P. Mathur and Dr. Raj Kumari Bhatnagar. Furthermore, data testing was carried out using mean, standard deviation and Critical Ratio Test. The results showed that adolescent girls of state and CBSE board are more aggressive than the boys. Also, the boys of CBSE board are more aggressive compared to state board. These results may be used as initial data by counselors for psychological intervention on aggressive behavior exhibited by adolescents.

Keywords : Aggressive behavior, adolescents, board of education, gender.

Introduction

Aggression is the tendency to fight and to hurt others under certain circumstances. It is defined as, 'any behavior directed towards the goal of harming or injuring another human being.'

In psychology and other social and behavioral sciences, aggression refers to behavior that is intended to cause harm or pain. Aggression can either be physical or verbal, and behavior is classified as aggression if it does not actually succeed in causing harm or pain. Behavior that accidently causes harm or pain is not aggression. Property damage and other destructive behavior may also fall under the definition of aggression.

Considering our enormous capacity for learning, it is not surprising that human being can learn to be aggressive. When frustrated we may feel angry, but according to social learning theory we only behave aggressively if we have observed aggressive models. Children who are controlled through aggression are, in turn, inclined to be aggressive themselves. Children who watch aggressive movies and television display significantly more aggression than do control subjects. Viewing aggressive behavior is a likely cause of aggression. (Bandura, 1965, 1973; Eron, 1972, 1982).

Aggression is a complex phenomenon that is composed of a number of more specific types of behavior. Moyer (1968) presented an early and influential classification of seven different forms of aggression, from a biological and evolutionary point of view.

Predatory aggression: attack on prey by a predator.

Inter-male aggression: competition between the males of same species over access to resources such as females, dominance, status etc.

Fear induced aggression: aggression associated with attempts to flee from a threat.

Irritable aggression: aggression induced by frustration and directed against an available target.

Territorial aggression: defence of a fixed area against intruders, typically co specifics.

Maternal aggression: a female's aggression to protect her off springs from threat. Paternal aggression also exists.

Instrumental aggression: aggression directed towards obtaining some goal, considered to be a learned response to a situation.

Factors causing Aggression

Frustration: One of the fundamental emotional reactions to frustration is aggression, some sort of hostile attack on the object that is perceived as producing the frustration.

Gender: Gender is a factor that plays a role in both human and animal aggression. Males are generally more aggressive than females (Coi & Dodge 1997, Maccoby & Jacklin 1974).

Genetics: While the exact amount of influence that genetics have is still questioned, studies on animals have shown that a tendency towards aggression is at least partly inherited (Gariepy et. Al. 1999).

Brain: The amygdala has been shown to be an area that causes aggression. Stimulation of the amygdala results in augmented aggressive behavior (DeCoster et al 1996), while lesions of this area greatly reduce one's competitive drive and aggression (Bauman et al 2006, Crews et al 1984).

Neurotransmitters and hormones: Testosterone have been shown to correlate with aggressive behavior in mice and in some humans (Gerra et al 1997). The neurotransmitter vasopressin causes an increase in aggressive behavior when present in large amounts in the anterior hypothalamus (Delville et al 1997).

Television: In movies, novels, plays and television, one can vicariously participate in any kind of violent act imaginable. It appears that exposure to violence in TV and movies have both a short-range and long-range effect on aggressive behavior at least for males in our culture (Bryan and Schwartz, 1971).

Culture: Empirical cross-culture research has found differences in the level of aggression between cultures. In one study, American men resorted to physical aggression more readily than Japanese or Spanish men, whereas Japanese men preferred direct verbal conflict more than their American or Spanish counterparts (Andreu et al 1998).

Statement of the Problem

It seems impossible today to thumb through a newspaper or watch the news without learning of some new and showing act of human violence. War, violent crime, murder, rape, and child abuse – all these serve to remind us of the frequency and dangerous nature of human aggression.

The range of human aggressive behaviors is quite vast. We speak of aggression in wartime. We also speak of displays of aggression and violence on television shows. Even intimates (best friends and married partners) often lash out at each other with damaging remarks and put-downs. It is quite a challenge to seek out the roots of aggression motivation.

Children are exposed to aggressive behavior from a very young age. Children love to imitate and right from a young age they start exhibiting aggressive behaviors that are copied. Thus, here an attempt has been made to study aggressive behavior as a function of gender and type of education.

Review of literature

Sidhu, T.K., Kaur, P., Sangha, N.K. & Bansal, A.S. (2019) studied the prevalence of aggression among adolescents and its associated risk factors. This was a community-based study conducted in the senior secondary schools of urban and rural field practice area of AIMSR. The total prevalence of aggression was found to be 51.9% with higher scores in urban population, males having more of physical aggression and females having hostility – associated significantly with the age distribution, residency type, etc. Interventions are needed to reduce the levels of aggression among adolescents and provide them a good future.

Kishore, J., Tripathi, N., Mandal, R.K., & Tomar, S.K. (2019) investigated aggression among school adolescents and the association of aggression with different socio-demographic characteristics among these students. The result showed that male adolescents displayed

significantly higher levels of aggressiveness as compared to female. Younger age showed higher level of aggressive scores than older age groups. Adolescents who were Hindus and had nuclear families with educated parents were found to have high aggressive scores as compared to other religion and joint families. However, these differences were not statistically significant.

Afdal, A., Fikri, M., Pane, N., & Andriani, W. (2020) studied to determine the extent to which students' aggressive behavior is predictable by gender and domicile origin. The participants of this study were a total of 2681 Indonesian teenagers aged 14-20 years. The results showed that male adolescents tend to show more aggressive behavior compared to females. Furthermore, it showed that the tendency of displaying aggressive behavior by adolescents in rural areas is more tenuous compared to those in suburbs of cities and cities.

Heizomi, H.; Jafarabadi, M.A.; Kouzekanani, K.; Matlabi, H.; Bayrami, M.; Chattu, V.K.; Allahverdipour, H. (2021) studied to understand the factors associated with aggressiveness among young teenage girls. Low parental support, low satisfaction with body image, high sense of loneliness, and lower perceived social acceptance were found to be the factors influencing aggressiveness. The current study found that the school environment, home environment, individual and interpersonal factors all play a part in aggressiveness.

Aim: The main aim of the study is to investigate the effect of gender and board of education on aggressive behavior in children.

Objectives:

- To assess the aggressive behavior of girls.
- To assess the aggressive behavior of boys.
- To investigate the differences in aggressive behavior of girls and boys.
- To assess the aggressive behavior of CBSE board students.
- To assess the aggressive behavior of state board students.
- To compare the aggressive behavior of students studying in state board with that of CBSE board.

Hypotheses:

- The aggressive behavior of boys studying in State board schools is significantly higher than the aggressive behavior of girls studying in State board schools.
- The aggressive behavior of boys studying in CBSE schools is significantly higher than the aggressive behavior of girls studying in CBSE schools.
- The aggressive behavior of girls studying in CBSE schools is significantly higher than the aggressive behavior of girls studying in State board schools.
- The aggressive behavior of boys studying in CBSE schools is significantly higher than the aggressive behavior of boys studying in State board schools.

Methodology:

Sample: The sample comprised of 200 school students of the age 14 to 16 years. The sex ratio was 1:1 i.e. 100 boys and 100 girls. So also, the board of education was 1:1.

Tool Used: Aggression Scale by Dr. G. P. Mathur/ and Dr. Raj Kumari Bhatnagar was used to study the level of aggression. It consists of 55 statements. Higher scores show high aggression level and lower scores show lower aggression level.

Variables: The depended variable in the study is aggressive behavior and the independent variables are gender and board of education.

Statistical Treatment: Initially the data was subjected to mean and standard deviation and was then subjected to Critical Ratio test.

Result and Discussion: The aim of the present study was to compare the aggressive behavior of State Board and CBSE board students.

Table No. 3.1
Mean, Standard Deviation & CR value of aggressive behavior in Girls and Boys of State Board Schools.

State Board	Mean	SD	CR Value
Girls	199.42	9.13	8.16**
Boys	178.68	9.63	

**significant at 0.01 level

The above table 3.1 reveals that the aggressive behavior of State Board girls (M=199.42, SD=9.13) is higher than the aggressive behavior of State Board boys (M=178.68, SD=9.63). the calculated CR Value is 8.16 which is significant at 0.01 level, which shows that there is a significant difference between the aggressive behaviors of girls and boys of State board boys.

The hypothesis states that State Board boys are more aggressive than State Board girls contrary to the assumption the study reveals that girls are more aggressive than boys, which may be due to their suppressed feelings, gender discrimination and insecurity.

Table No. 3.2
Mean, Standard Deviation & CR value of aggressive behavior in Girls and Boys of CBSE Board Schools.

CBSE Board	Mean	SD	CR Value
Girls	203	9.96	4.37**
Boys	192.5	9.18	

**significant at 0.01 level

Taking a look at the table no. 3.2 we come to know that the aggressive behavior of girls of CBSE (M=203, SD=9.96) is greater than that of boys of CBSE (M=192.5, SD=9.18). The calculated CR value is 4.37 which reveals that there is a significant difference between the aggressive behavior of girls and boys of CBSE.

The hypothesis states that the boys of CBSE are more aggressive than the girls of CBSE. The results shows that the girls of CBSE are more aggressive than the boys of CBSE, which may be due to their suppression of feelings, gender discrimination and too much of ethics imposed on them.

Table No. 3.3
Mean, Standard Deviation & CR value of aggressive behavior in Girls of State board and CBSE Schools.

Option	Mean	SD	CR Value
Girls State Board	199.42	9.13	1.43
Girls CBSE	203	9.96	

Table 3.3 shows that the aggressive behavior of girls of CBSE (M=203, SD=9.96) is higher than the aggressive behavior of girls of State board (M=199.42, SD=9.13). the calculated CR Value is 1.43, which is non-significant at 0.05 level.

The hypothesis states that the girls of CBSE are more aggressive than the girls of State board but the CR value is rejected at both the levels, thus the difference in the mean may be due to the factor of chance and there is no significant difference in the aggressive behavior of girls of State board and CBSE. Type of board of education failed to influence the aggression in girls.

Table No. 3.4
Mean, Standard Deviation & CR value of aggressive behavior in boys of State board and CBSE Schools.

Option	Mean	SD	CR Value
Boys State Board	178.68	9.63	5.64**
Boys CBSE	192.5	9.18	

**significant at 0.01 level

As per the above table 3.4, the aggressive behavior of CBSE boys (M=192.5, SD=9.18) is more than the aggressive behavior of boys of State board (M=178.68, SD=9.63). the calculated CR value is 5.64 which shows that there is significant difference between the aggressive behavior of boys of State board and CBSE.

The hypothesis states that the aggressive behavior of boys of CBSE is significantly more than that of boys of State board; which is accepted at both the levels of significance. This shows that the boys of CBSE are more aggressive than those of State board, which may

be due to the more permissive atmosphere that they get.

Conclusion:

- The difference between the aggressive behavior of girls and boys of State board is significant i.e. the girls of State board are more aggressive than the boys of State board.
- The difference between the aggressive behavior of girls and boys of CBSE is significant i.e. the girls of CBSE are more aggressive than the boys of CBSE.
- There is no significant difference between the aggressive behavior of girls of State board and CBSE.
- There is a significant difference between the aggressive behavior of boys of State board and CBSE i.e. the boys of CBSE are more aggressive than the boys of State board.

Recommendations:

- A large representative sample may be taken to get reliable results.
- Other variables like socio-economic status, type of family can be studied with aggressive behavior.
- Every school and college should have a counselor to help the students to cope up their problems.

Suggestions:

- Students should attend workshop and seminars for anger and stress management.
- They should also involve themselves in some or the other kind of physical exercises.
- Eating simple food with less amount of spices also helps in reducing anger.
- Meditation is also helpful to curb aggression.

Limitations:

- The study was restricted to a small sample size of 200 students.
- Only two variables gender and type of education were studied.
- Other variables like type of family, culture, intelligence could have been studied.

REFERENCES:

- Afdal, A., Fikri, M., Pane, N., & Andriani, W. (2020). Exploration of aggressive behavior among adolescent in Indonesia. Konselor, 9(4), 165-173. doi: https://doi.org/10.24036/0202094111914-0-00
- Heizomi, H.; Jafarabadi, M.A.; Kouzekanani, K.; Matlabi, H.; Bayrami, M.; Chattu, V.K.; Allahverdipour, H. (2021). Factors Affecting Aggressiveness among Young Teenage Girls: A Structural Equation Modeling Approach. Eur. J. Investig. Health Psychol. Educ, 11, 1350–1361. https://doi.org/10.3390/ ejihpe11040098
- Kishore, J., Tripathi, N., Mandal, R.K., & Tomar, S.K. (2019). Aggression among School Adolescent and its Association with Socio-Demographic Characteristics: A Cross Sectional Study. Ind J Youth Adol Health, 6(2), 7-13.
- Ramirez, M. & Andreu, J. (2003). Aggression's Typologies. Revue Internationale De Psychologie Sociale, 16 (3), 125-141. Retrieved from https://www.researchgate.net/publication/48932416_Agression's_typologies
- Sidhu, T.K., Kaur, P., Sangha, N.K. & Bansal, A.S. (2019). Aggression among adolescents – A cross-sectional study. Adesh University J Med Sci Res, 1(1), 21-26.
- Soreff SM, Gupta V, Wadhwa R, et al. (2022) Aggression. [Updated 2022 Oct 3]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing, Retrieved from: https://www.ncbi.nlm.nih.gov/books/NBK448073/

A Study Of Life Satisfaction And General Well-being Among Women

***Apeksha V. Dhote and ** Dr Shraddha Thacker**

*PG Student of Human Development

**Correspondence author, Asst. Professor, L.A.D. and Smt. R.P. College for Women, Nagpur

Abstract

Life satisfaction is a cognitive and affective evaluation of a person's life. It's based on how a person's aspirations compare to their achievements, and evaluation of a person's quality of life. It is assessed in terms of mood, relationship satisfaction, achieved goals, self-concepts, and the self-perceived ability to cope with life. Life satisfaction involves a favourable attitude towards life, rather than an assessment of current feelings. Life satisfaction has been measured in relation to economic standing, degree of education, experiences, residence, and other factors. For the present study sample size consisted of 100 women, 50 working and 50 non-working in the age range of 25 to 45 years by using stratified random sampling. PGI General Well Being Measure by S.K. Verma and Anita Verma (1989) and Life satisfaction scale by Dr. Promila Singh and Gorge Joseph (1971) were employed for data Collection. The data was treated with mean, standard deviation and one-way ANOVA. The result analysis revealed that working women have significantly higher life satisfaction than non-working women. They also revealed higher well-being than non-working women.

Key words : general well-being, life satisfaction, working vs non-working women

Introduction : Life satisfaction is a person's overall assessment of their life at a given time. It's a measure of how happy someone is with their life, and how well their current situation meets their needs. Life satisfaction is a key indicator of well-being, along with positive and negative affect. Life satisfaction is a key part of subjective well-being. Many factors influence subjective well-being and life satisfaction. Socio-demographic factors include gender, age, marital status, income, and education. Psychosocial factors include health, illness, functional ability, activity level, and social relationships. People tend to gain life satisfaction as they get older.

Buetell (2006) – "An overall assessment of feelings and attitudes about one's life at a particular point in time ranging from negative to positive."

Ruut Veenhoven (1996)- "Life satisfaction is the degree to which a person positively evaluates the overall quality of his/her life as a whole. In other words, how much the person likes the life he/she leads.'

Ellison and colleagues (1989)- defines Life Satisfaction as, "A cognitive assessment of an underlying state thought to be relatively consistent and influenced by social factors."

Although there are small differences between the definitions, the underlying idea is the same: life satisfaction refers to an individual's overall feelings about his or her life. In other words, life satisfaction is a global evaluation rather than one that is grounded at any specific point in time or in any specific domain. Life satisfaction is a bit more complex than it seems; the term is sometimes used interchangeably with happiness, but they are indeed two separate concepts. Life satisfaction is the evaluation of one's life, not simply one's current level of happiness. Life satisfaction is widely considered to be central aspect of human welfare. Life satisfaction is not merely a judgement about one's life. For it is widely thought to involve affirming, endorsing, appreciation or being pleased with one's life. Life satisfaction refers to a person's general happiness freedom from tension, interest in life etc.

Factors influencing Life Satisfaction: Life satisfaction refers to a person's overall

assessment of their quality of life according to their own chosen criteria. It is a key component of subjective well-being and represents how content individuals are with their lives as a whole. Life satisfaction is influenced by a variety of factors, both internal and external, that interact in complex ways. Below are the major factors:

1. Psychological Factors

- Personality Traits: Traits like optimism, emotional stability, resilience, and openness are positively linked to higher life satisfaction. Neuroticism, on the other hand, is often negatively correlated.
- Self-Esteem: People with high self-esteem tend to view life more positively and report higher levels of satisfaction.
- Cognitive Style: Those who focus on gratitude, practice mindfulness, and use positive reframing tend to experience greater life satisfaction.

2. Social Relationships

- Family and Friends: Strong, supportive relationships with family and close friends greatly enhance life satisfaction. Social support acts as a buffer against stress and emotional distress.
- Community Engagement: Feeling connected to a community and participating in social or group activities also boost one's sense of belonging and satisfaction.
- Romantic Relationships: Quality of romantic or marital relationships plays a crucial role in adult life satisfaction.

3. Economic and Financial Factors

- Income: Although higher income can increase life satisfaction, especially in low-income settings, its impact tends to plateau after basic needs are met (known as the "income threshold" effect).
- Job Satisfaction: Having meaningful, stable employment that aligns with one's values and skills contributes significantly to overall well-being.
- Financial Security: The feeling of financial control and security often outweighs actual wealth in influencing satisfaction.

4. Physical and Mental Health

- Health Status: Good physical health and the absence of chronic illness are strongly correlated with higher life satisfaction.
- Mental Health: Depression, anxiety, and other mental health conditions can significantly lower life satisfaction if untreated.
- Healthy Habits: Regular exercise, a balanced diet, and adequate sleep positively influence mood and long-term satisfaction.

5. Education and Personal Development

- Educational Attainment: Higher education levels are often linked with greater life satisfaction due to increased opportunities and personal growth.
- Lifelong Learning: Engagement in learning or skill-building at any age promotes a sense of purpose and satisfaction.
- Autonomy and Personal Control: The ability to make independent choices and have control over one's life strongly affects satisfaction.

6. Cultural and Environmental Factors

- Cultural Values: Societies that value collectivism vs. individualism, material success vs. well-being, or spirituality vs. secularism can influence how people perceive satisfaction.
- Social Equality: Living in a society with low levels of inequality and high social trust often correlates with greater life satisfaction.
- Environment and Safety: Clean surroundings, access to nature, and a sense of safety and security also contribute to well-being.

7. Spirituality and Religion

- Faith and Belief Systems: Spiritual practices and religious beliefs often provide individuals with a sense of purpose, hope, and community.
- Religious Participation: Regular involvement in religious or spiritual groups can increase life satisfaction through social connection and structured meaning-making.

8. Life Events and Circumstances

- Major Life Events: Events like marriage, childbirth, career achievements, or losses (such as death or divorce) have a significant impact, positively or negatively.
- Adaptation: People tend to adapt over time to both positive and negative events, a process known as the "hedonic treadmill."
- Goal Achievement: Setting and achieving personal goals, especially intrinsic ones (like self-growth), enhances life satisfaction.

Well Being: Well-being is a multidimensional concept that refers to how a person feels about themselves and their life. It's a combination of a person's physical, mental, emotional, and social health factors. Well-being is closely linked to happiness and life satisfaction. Psychological well-being (PWB) is a core feature of mental health. Subjective well-being is how much a person experiences positive emotions and feelings of happiness. PWB is relatively stable, but it can be influenced by a person's previous experiences, personality, and day-to-day events. Some skills that can help improve well-being include: Mindfulness, Positive thinking, Resilience, and Forgiving others.

Well-being is what is ultimately good for a person or in their self-interest. It is a measure of how well a person's life is going for them. In the broadest sense, the term covers the whole spectrum of quality of life as the balance of all positive and negative things in a person's life. More narrowly, well-being refers specifically to positive degrees, while ill-being denotes negative degrees. The precise definition of well-being is disputed and varies across disciplines and cultures. Some characterizations focus on a single element, like happiness, while others include multiple components, such as good physical and mental health, positive emotions, an engaged and flourishing lifestyle, inner harmony, and positive interpersonal relationships.

Ed Diener (1984)- Subjective well-being (SWB) is a person's cognitive and affective evaluations of their life, encompassing both their thoughts and feelings about their experiences and satisfaction.

Martin Seligman (2011) Well-being is a combination of positive emotions, engagement, relationships, meaning, and accomplishment (PERMA), which, when nurtured, leads to flourishing, or optimal functioning.

WHO's (World Health Organisation): The WHO defines health, which encompasses well-being, as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity".

Wellbeing is not just the absence of disease or illness. It's a complex combination of a person's physical, mental, emotional and social health factors. Wellbeing is strongly linked to happiness and life satisfaction. In short, wellbeing could be described as how one feels about oneself and life.

Factors influencing wellbeing:

1. Psychological and Emotional Factors

- **Emotional Regulation:** The ability to manage emotions positively contributes to long-term well-being.
- **Positive Thinking:** Optimism, gratitude, and a hopeful outlook help individuals cope with stress and maintain higher levels of happiness.
- **Self-Esteem and Self-Compassion:** Feeling good about oneself and being kind to oneself during failures enhance emotional resilience.

2. Physical Health

- **Nutrition:** A balanced, nutritious diet supports brain and body health, which directly affects mood and energy levels.
- **Exercise:** Regular physical activity boosts endorphins, reduces stress, and improves sleep and self-image.
- **Sleep:** Quality sleep restores physical and mental functions and is strongly tied to emotional stability.
- **Avoiding Harmful Substances:** Limiting or avoiding alcohol, drugs, and tobacco supports better mental and physical health.

3. Social and Relationship Factors

- **Social Support:** Strong, supportive relationships with friends, family, and community are key to emotional well-being.
- **Belonging:** Feeling accepted and valued in social groups contributes to identity and self-worth.
- **Communication:** Open, honest communication helps in conflict resolution and deepening connections.

4. Environmental Factors

- **Living Conditions:** Clean, safe, and comfortable living environments contribute to peace of mind and health.
- **Access to Nature:** Spending time in green spaces or natural environments reduces stress and boosts mood.
- **Community Safety:** Feeling safe in one's neighbourhood or city reduces anxiety and supports overall well-being.

5. Economic and Financial Stability

- **Income:** While wealth does not guarantee happiness, sufficient income to meet basic needs is essential for well-being.
- **Job Satisfaction:** Meaningful and stable employment supports self-esteem, routine, and financial independence.
- **Financial Security:** Having savings and not constantly worrying about money reduces stress and supports long-term happiness.

6. Education and Personal Development

- **Educational Opportunities:** Access to quality education helps in personal growth, critical thinking, and employment opportunities.
- **Skill Development:** Engaging in lifelong learning or hobbies promotes a sense of purpose and competence.
- **Sense of Achievement:** Setting and achieving goals boosts confidence and motivation.

7. Spirituality and Belief Systems

- **Faith and Meaning:** Spiritual or religious beliefs can provide a sense of purpose, comfort, and moral guidance.
- **Rituals and Practices:** Meditation, prayer, or mindfulness practices can reduce anxiety and promote inner peace.

8. Cultural and Societal Influences

- **Social Norms and Values:** Cultural expectations about success, family, or happiness influence personal definitions of well-being.
- **Equality and Inclusion:** Living in a society that promotes fairness, inclusion, and diversity enhances collective well-being.
- **Freedom and Autonomy:** Being able to make choices about one's own life is crucial to personal fulfilment.

9. Work-Life Balance

- **Time Management:** Balancing responsibilities between work, family, and personal time is key to reducing burnout.
- **Rest and Recreation:** Taking breaks and engaging in leisure activities helps recharge and promotes happiness.

10. Mental Health and Support Services

- **Access to Therapy or Counseling:** Professional mental health support can help individuals manage anxiety, depression, trauma, and other challenges.
- **Awareness and Education:** Understanding mental health reduces stigma and encourages help-seeking behavior.

Significance of the Study:

This study holds significance in understanding the psychological and social dimensions of women's lives in the contemporary context. As more women balance personal and professional responsibilities, examining their life satisfaction and well-being offers valuable insights into how employment status influences mental and emotional health. By focusing on women aged 25 to 45 often considered a prime age for career growth, family development, and self-identity, the present study focuses on a crucial life stage where external pressures and internal expectations often converge. The comparison between working and non-working women sheds light on the impact of employment on psychological well-being, helping to identify whether occupational engagement contributes positively to life satisfaction or if alternative factors play a more critical role.

Aim of the Study: To examine and compare the levels of life satisfaction and well-being among working and non-working women in the age group of 25 to 45 years.

Objectives

1. To assess the level of life satisfaction among working and non-working women aged 25–45 years.
2. To measure the level of well-being among working and non-working women aged 25–45 years.
3. To compare life satisfaction between working and non-working women.
4. To compare well-being between working and non-working women.

Review of literature: Recent studies have explored the relationship between working status and psychological well-being among women. **Chandra, Ram, and Sinha (2024)** assessed psychological well-being among working and non-working women in Bihar and found that overall well-being and dimensions such as personal growth, positive relations, and self-acceptance were higher among working women, whereas autonomy and environmental mastery were comparatively higher among non-working women. Similarly, **Singh, and Thakor (2024)** examined life satisfaction among working and non-working women across urban and rural areas and reported a significant difference based on working status, although no difference was found based on residential location. **Chaurasia and Kumar (2023)** found that working women exhibited higher psychological well-being and self-efficacy compared to housewives, though some dimensions such as environmental mastery and positive relations did not show significant differences. Further supporting the role of employment in shaping women's well-being, **Singh and Singh (2023)** reported that working women had higher life satisfaction, whereas non-working women demonstrated better adjustment abilities. **Pandey and Singh (2021)** also reported higher life satisfaction among working married women, especially in rural settings. Earlier studies have similarly emphasized the impact of employment on women's well-being. **Annu (2020)** found that working women demonstrated better general well-being compared to non-working women, with age also playing a significant role. **Bano (2019)** reported significant differences in adjustment and well-being between working and non-working women, indicating that employment contributes positively to psychological outcomes. In another study, **Chaudhary (2017)** found that working women had higher life satisfaction but also experienced greater stress due to work-family conflict. Earlier research further supports these

findings. **Singh (2014)** found that working women had greater life satisfaction and lower stress compared to non-working women, and also reported a negative correlation between stress and life satisfaction. One of the earliest studies **by Rathi and Sahu (2003)** highlighted that working women exhibited higher self-efficacy and well-being compared to non-working women, and also established a strong relationship between self-efficacy and overall well-being. Overall, the reviewed studies indicate that working status plays a significant role in influencing women's life satisfaction, psychological well-being, and related variables such as self-efficacy, adjustment, and stress.

Research Methodology:

Sample: The sample size for this research study consisted of 100 women, divided equally into two groups: 50 working women and 50 non-working women from the Nagpur district. The participants were in the age range of 25 to 45 years. The sampling techniques used for data collection was stratified random sampling.

Tool Used: PGI General Well Being Measure by S.K. Verma and Anita Verma (1989) was used to assess well-being of the subjects. The scale consists of 20 items. Each response is rated as 1 and the total score is interpreted using the norms as: High (14-20), Average (7-13), Low (1-6) accordingly. The reliability of the 'PGI General wellbeing test' was determined by test – retest method (r = 0.88). The validity of the 'PGI General wellbeing test' was determined by convergent method (r = 0.90).

Life satisfaction scale (Dr. Promila Singh and Gorge Joseph,1971)- The scale measures Life satisfaction on 5 dimensions- 1) taking pleasure in everyday activities, 2) considering life meaning full, 3) holding a self-image, 4) having a happy and optimistic outlook, 5) experience of success in achieving goals. The scale is available in both Hindi and English language and easy to score. It covers 35 items based on the dimensions described above. Each item has 5 response categories specifically; "always", "often", "Sometimes", "rarely", and "never". All these responses have a numerical weight age on 1-5 scale in descending order; where "Always" is rated 5 and "never" as 1 respectively. Scoring of response can be done by summing up the individual response weight age and interpreting it against norms; which indicate scores ranging from 136-175 as high, 81-135 as average and 35-80 as low life satisfaction. Its test-retest reliability is 0.91 it has content and face validity since every item was judged by experts.

Procedure for Data Collection: The sample was selected using random sampling. A rapport was established with the participants, and data collection was conducted at a mutually convenient time. The investigator explained the purpose of the research and assured participants of the confidentiality of their responses. Data was collected individually. Initially, the General Well-being measure was administered, following the instructions provided in the test manual. Any doubts or questions were addressed before the participants proceeded. After completion of the first test, the Life Satisfaction Scale was administered with appropriate instructions. The completed questionnaires were collected, and participants were thanked for their cooperation. This procedure was consistently followed for all participants in the sample.

Hypotheses

1. There exists significant difference in life satisfaction between working and non-working women aged 25–45 years.
2. Significant difference exists with respect to well-being between working and non-working women aged 25–45 years.

Variables under study:

1. Dependent variable: Life satisfaction and Well-being
2. Independent variable: Employment status-Working vs non-working women

Statistical treatment: Initially, the data was

treated with descriptive analysis- mean and standard deviation and for further inferential purpose, one-way ANOVA was employed.

Result Analysis and Discussion: The first objective of the study was to assess the levels of life satisfaction among women experienced by both groups i.e. working and non-working.

Table 1:
Frequency and Percentage of levels of Life Satisfaction

Levels of life satisfaction	Working women		Non-working women	
	Frequency	Percentage	Frequency	Percentage
High	42	84%	21	42%
Average	8	16%	29	58%
Low	NIL	NIL	NIL	NIL

Table no 1 represents the frequency and percentage distribution of life satisfaction levels among working and non-working women. Among working women, 84% (42 out of 50) reported high life satisfaction, while 16% reported average levels, and none reported low satisfaction. In contrast, 42% of non-working women reported high life satisfaction, while a higher proportion, 58%, fell into the average category, with none reporting low satisfaction. This indicates that working women tend to have higher life satisfaction compared to non-working women in the study sample.

Table 2:
Frequency and Percentage of levels of Well-being

Levels of life Well-being	Working women		Non-working women	
	Frequency	Percentage	Frequency	Percentage
High	38	76%	33	66%
Average	12	24%	17	34%
Low	NIL	NIL	NIL	NIL

Table no 2 displays the frequency and percentage of well-being levels among working and non-working women. Among working women, 76% (38 out of 50) reported high well-being, while 24% revealed the average category, with none reporting low well-being. In comparison, 66% of non-working women reported high well-being and 34% reported average levels, with no participants in the low category. Overall, both groups show a predominance of high well-being, but working women have a slightly higher proportion than non-working women.

Table 3:
Mean and SD of level of Life satisfaction and Well-being

Group	Descriptive statistics	Well-being	Life Satisfaction
Working Women	**Mean**	16.8	147.4
	SD	3.3	12.3
Non-working Women	**Mean**	15.8	134.5
	SD	2.8	10.8

Table no 3 represents descriptive statistics (Mean and Standard Deviation) for Well-being and Life Satisfaction among Working Women and Non-working Women. It can be observed that working women have a slightly higher average well-being score (16.8) than non-working women (15.8). With respect to Life Satisfaction, it can be found that Working women also report a higher life satisfaction score on average (147.4) compared to non-working women (134.5). The results have been illustrated in the following graph-

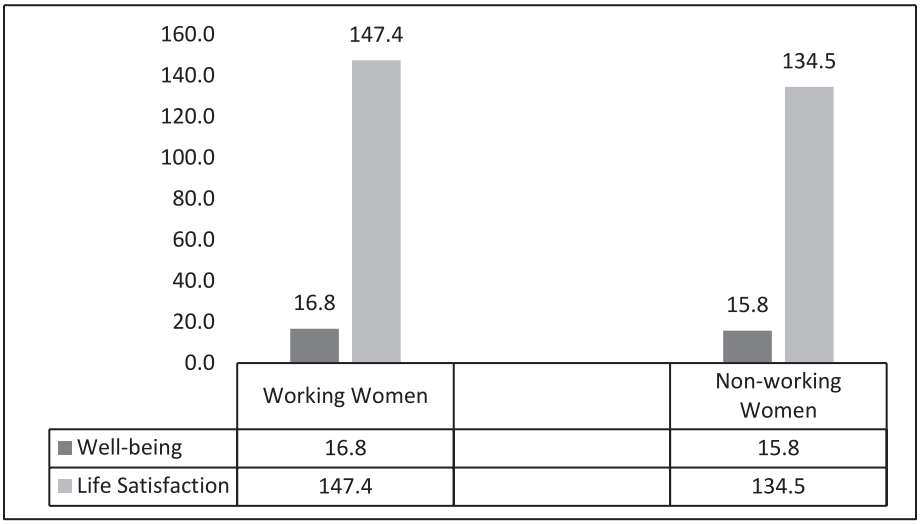


Figure 1: Mean and SD of level of Life satisfaction and Well-being

However, it cannot be asserted that these differences are significant only on the basis of descriptive statistics and hence the data was subjected to one-way ANOVA. The complete summary of one-way ANOVA is displayed in table 4:

Table 4: Complete Summary of One-way ANOVA for Life satisfaction among working and non-working women

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	4160.25	1	4160.25	**30.87**	**<0.05**	**6.9****
Within Groups	13206.5	98	134.76			
Total	17366.75	99				

****significant at 0.01 level**

It can be observed from the table no 4 that the calculated F-value (30.87) is much greater than the critical F-value (6.9) and the P-value is less than 0.01, indicating that there is a significant difference in life satisfaction between working and non-working women. Thus, the hypothesis framed "There exists significant difference in life satisfaction between working and non-working women aged 25–45 years" is accepted.

The significant difference may be due to greater financial independence and a sense of contribution among working women. Working women also have structured routine and social interaction at the workplace thus enhancing self-esteem and personal growth opportunities that

come with employment. Contrasting to this, non-working women may face role confinement or reduced access to external sources of satisfaction.

Similar results have been observed by **Chaudhary Sunil (2017)** that magnitude of life satisfaction was significantly higher among working women. **Singh, G. & Singh, J. (2023)** revealed that working women exhibited significantly higher life satisfaction scores than non-working women. The authors concluded that employment contributes positively to women's life satisfaction. **Machhi, Y. V. & Thakor, I. D. (2022)** found a significant difference in life satisfaction levels between working and non-working women, with working women reporting higher satisfaction. Singh, **S. K. (2014)** indicated that working women had significantly higher life satisfaction and lower stress levels compared to non-working women. The study highlighted the positive impact of employment on women's psychological well-being.

Table 5: Complete Summary of One-way ANOVA with respect to Well-being among working and non-working women

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	24.01	1	24.01	**2.62**	**0.108**	**3.9**
Within Groups	896.58	98	9.15			
Total	920.59	99				

Table 5 represents the results of one-way ANOVA conducted to examine the difference in well-being between working and non-working women. The analysis revealed that the calculated F-value is 2.62, which is less than the critical F-value of 3.9 at the 0.05 level of significance. Additionally, the p-value is 0.108, which is greater than 0.05, indicating that the difference in well-being between the two groups is not statistically significant. This means that while working women showed slightly higher mean well-being scores than non-working women, the variation is not strong enough to conclude a significant difference. Thus, the hypothesis framed "There exists significant difference in well-being between working and non-working women aged 25–45 years" is rejected. The result also suggests that the difference seen is may be due to chance factor and factors influencing well-being might be more diverse and complex, potentially affected by personal, social, and psychological variables beyond employment status alone.

Similar result was found in one the recent study undertaken by **Tiwari, L. (2024)** which concluded that psychological well-being was greater among non-working women compared to working women. However, no significant difference was found in self-efficacy between the two groups. Another work by **Anand, S. & Sharma, M. (2017)** found that non-working females had better scores in physical, psychological, and environmental domains compared to working females. However, these differences were not statistically significant, except in the social domain.

Thus, the results of present study align with previous research suggesting that employment contributes positively to women's mental health by providing social engagement, financial independence, and a sense of purpose. Conversely, non-working women may face challenges such as reduced autonomy, limited social interaction, or economic dependency, which could contribute to lower well-being scores. It is important to consider that well-being and satisfaction are multifactorial, and while employment is a strong contributing factor, other

aspects such as family support, marital status, and individual personality traits may also play important roles.

Conclusion:

- Working women revealed significantly higher life satisfaction than non-working women.
- Working women revealed though not significant but better well-being than non-working women.

Limitations:

- The data was limited to only 100 women.
- Only two variables were studied.

Suggestions

- The study could have included the intervening variables like socio-economic status, marital status.
- A larger sample can be taken for better representative results.

Recommendations

- Employment has positive effects on women's health. Hence, it is recommended that women should involve themselves in gainful employment to enhance their sense of purpose, autonomy, and financial independence, which collectively contribute to higher life satisfaction and well-being.
- Women should be encouraged to pursue personal growth opportunities, such as learning new skills, engaging in creative activities, or taking up part-time work or volunteering.
- Access to emotional and mental health resources like counselling sessions, mindfulness training should be strengthened for both working and non-working women. Regular counselling sessions, mindfulness training, or peer support groups can help manage stress and promote emotional resilience.

REFERENCES:

- Agnes, M. & Akhila, P.J. (2023). Mental Health and Life Satisfaction: A Comparative Study Among Working and Non-Working Women. International Journal of Indian Psychology, 11(2), 2306-2313. Retrieved from https://ijip.in/articles/mental-health-and-life-satisfaction-a-comparative-study-among-working-and-non-working-women/
- Akhila, P.J., & Paul, B. (2022). Mental Health and Life Satisfaction: A Comparative Study among Working and Non-working Women's. International Journal of Indian Psychology, 10(4), 657-664. Retrieved from https://ijip.in/articles/mental-health-and-life-satisfaction-a-comparative-study-among-working-and-non-working-womens/
- Annu, S. (2020). A Study of general well-being in working and non-working women. International Journal of Indian Psychology, 8(4), 192-196. Retrieved from https://ijip.in/articles/a-study-of-general-well-being-in-working-and-non-working-women/
- Arshad, M., Gull, S. & Mahmood, K. (2015). Life satisfaction among working & non-working women. European Journal of Research in Social Science, 3(1), 121-127. Retrieved from https://www.idpublications.org/wp-content/uploads/2014/10/LIFE-SATISFACTION-AMONG-WORKING-AND-NON-WORKING-WOMEN-Full-Paper.pdf
- Bano, S. (2019). Level of Well-Being Among Working and Non-Working Married Women Concerning Adjustment: A Comparative Study. Journal of Emerging Technologies and Innovative Research, 6 (2), 1563-1574. Retrieved from https://www.jetir.org/papers/JETIR1902E24.pdf
- Buetell, N. (2006). Life satisfaction, a Sloan Work and Family Encyclopedia entry. Retrieved May 10, 2007, from the Sloan Work and Family Research Network website: http://wfnetwork.bc.edu/encyclopedia_entry.php?id=3283&area=academics.
- Chandra, N., Sinha, A. & Ram, J. (2024). Psychological Well-Being Between Working and Non-Working Women of Muzaffarpur District in Bihar. Shodhkosh: Journal of Visual and Performing Arts, 5 (2). Retrieved from https://www.granthaalayahpublication.org/Arts-Journal/ShodhKosh/article/view/2206
- Chauhan, A. (2015). A Comparative Study On Life Satisfaction Among Working And Non-Working Women. International Journal of Research in Social Sciences and Humanities, 5 (4), 165-168. Retrieved from https://www.ijrssh.com/admin/upload/17%20Dr%20Anshu%20Chauhan%2001299.pdf
- Choudhary, L. & Ahmad, A. (2017). A Study of

Psychological Well-Being Among Housewives and Working Women of Mithila Region, North Bihar, India, International Education and Research Journal, 9 (7). Retrieved from https://ierj.in/journal/index.php/ierj/article/view/2825

- Choudhary, S. (2017). Life Satisfaction and Stress Among Working Women and Housewives. A Journal of Advances in Management IT & Social Sciences, 7 (7), 97-103. Retrieved from https://www.academia.edu/34200365/LIFE_SATISFACTION_AND_STRESS_AMONG_WORKING_WOMEN_AND_HOUSEWIVES
- Chaurasia, K. & Kumari, A. (2023). A Study of Psychological Well-Being and General Self-Efficacy Among Housewives and Working Women. International Education and Research Journal, 9(7). Retrieved from https://ierj.in/journal/index.php/ierj/article/view/2825
- Life Satisfaction Theory & 4 Contributing Factors. Retrieved from https://positivepsychology.com/life-satisfaction/
- Machhi, Y., Singh, I. & Thakor, I.D. (2024). Life Satisfaction Among Working and Non-Working Women. International Journal of Indian Psychology, 12(1), 1676-1682. Retrieved from https://ijip.in/articles/life-satisfaction/
- Mahato, K. (2017). Factors Effecting Life Satisfaction. Journal of Research in Humanities & Soc. Sciences, 5 (2), 16-18. Retrieved from https://www.raijmr.com/ijrhs/wp-content/uploads/2022/10/3_16-18-Kamal-Kumar-Mahato.pdf
- Pandey, K. (2023). A Study of the Impact of Social Media Use among Working and Non-Working Women in Varanasi. International Journal of Indian Psychology, 11(4). Retrieved from https://ijip.co.in/index.php/ijip/article/view/6484
- Promoting Well-being. Retrieved from https://www.who.int/activities/promoting-well-being
- Rath, S. & Sahu, F. M. (2003). Self-efficacy and Wellbeing in Working and Non-working Women: The Moderating Role of Involvement. Psychology and Developing Societies, 15(2), 187-200. Retrieved from https://journals.sagepub.com/doi/10.1177/097133360301500205
- Singh, G. & Singh, J. (2023). A Comparative Study of Working and Non-Working Women on Adjustment and Life Satisfaction. International Journal of Indian Psychology, 11(2). Retrieved from https://ijip.co.in/index.php/ijip/article/view/5520
- Singh, P., Joseph, G. (1996). Life Satisfaction Scale, Agra: National Psychological Corporation.
- Subjective Wellbeing in Positive Psychology. Retrieved from https://positivepsychology.com/subjective-well-being/
- Veenhoven, R. (1996). "The study of life satisfaction. Retrieved from https://personal.eur.nl/veenhoven/Pub1990s/96d-full.pdf
- Verma,S.K. & Verma, A.(1989).“PGI general wellbeing Questionnaire”. Agra : National Psychology Center.
- Zafar, M. & Rahman, B. (2022). Life Satisfaction Among Working and Non-Working Women. Advances in Business and Commerce, 10(2), 09-17. Retrieved from https://www.researchgate.net/publication/364903180_Life_Satisfaction_Among_Working_and_Non-Working_Women

Sustainable Vernacular Building Traditions of Vidarbha: A Study Across Selected Agro-Climatic Zones

Dr. Seema M. Burele

Smt. Manoramabai Mundle College of Architecture, Nagpur, Maharashtra
Email: seemazade3@gmail.com

Abstract

Vernacular architecture represents an indigenous system of building that evolves in response to local environmental, cultural, and socio-economic conditions. It utilizes locally available materials, traditional construction techniques, and community knowledge developed over generations. As a result, vernacular architecture provides valuable insights into sustainable design principles and resource-efficient construction practices. The Vidarbha region of Maharashtra possesses a rich tradition of vernacular construction practices, particularly in rural settlements where buildings demonstrate a strong relationship with climate, locally available materials, and cultural practices. This study investigates the vernacular architecture of selected household across different agro-climatic zones of Vidarbha from a sustainability perspective. Case studies were identified from the Assured Rainfall Zone, Moderate Rainfall Zone, and High Rainfall Zone. Data were collected through reconnaissance surveys, visual documentation, measured drawings, field observations, and structured interviews with homeowners. The study analyses spatial organization, locally available material and construction techniques of traditional houses. The findings reveal that vernacular construction practices in Vidarbha embodies key principles of sustainability through efficient utilization of natural resources with minimal environmental impact, and preservation of regional identity. The research demonstrates that indigenous construction knowledge remains relevant and offers valuable lessons for contemporary sustainable architectural practices.

Key words : vernacular architecture, sustainability, agro climatic zone, spatial organization.

Introduction :

The term vernacular originates from the Latin word vernaculus, meaning native, domestic, or indigenous. Vernacular architecture refers to building practices that employ locally available materials, traditional knowledge, and regional construction methods to meet the needs of a specific community. Unlike formally designed architecture developed by professional architects, vernacular architecture evolves through continuous adaptation to local environmental, cultural, and socio-economic conditions.

According to Rapoport, vernacular traditions represent the values, aspirations, lifestyles, and cultural identities of communities through their built environments. These buildings are often shaped by accumulated experience and collective knowledge rather than formal engineering calculations. Consequently, vernacular architecture reflects a harmonious relationship between people, place, and climate. Vernacular buildings typically incorporate bioclimatic design principles and extensively utilize locally available materials. Their construction methods are refined through generations of experimentation and adaptation, making them environmentally responsive and resource efficient. Such architectural traditions have remained a valuable source of reference for studies related to culture, society, sustainability, and climate-responsive design. The Vidarbha region of Maharashtra possesses a diverse and distinctive vernacular architectural heritage, particularly in rural settlements. Variations in climate, topography, rainfall, and material availability have resulted in region-specific construction techniques and spatial configurations. This study examines selected examples of vernacular construction practices from three agro-climatic zones of Vidarbha to

understand their spatial organization, construction technologies through the perspective of sustainability.

2 Sustainable Architecture

Sustainable architecture seeks to create built environments that are environmentally responsible, economically viable, and socially beneficial. It emphasizes the efficient use of resources, reduction of environmental impacts, and the creation of healthy and adaptable living environments.

Samuel Mockbee described sustainable architecture as a process that integrates environmental, social, political, moral, and aesthetic values while maintaining harmony between human needs and the natural environment. According to Edwards (2005), sustainability in architecture encompasses the design of spaces that are environmentally sensitive, socially responsive, and economically feasible while respecting ecological systems and natural processes (Fig.1)

The fundamental principles of sustainable architecture include:

- Minimizing adverse environmental impacts.
- Conserving natural resources.
- Enhancing energy efficiency.
- Promoting ecological balance and biodiversity.
- Supporting social and cultural continuity.
- Utilizing locally available and renewable materials.

The Vernacular construction practices in Vidarbha demonstrates many of these principles through its reliance on local resources, climate-responsive design strategies, and traditional construction technologies. Consequently, it provides an appropriate framework for understanding sustainable architecture in a regional context.



Figure. 1 Dynamic model of sustainability
[Source: Architectural science forum (2002)]

The concept of sustainability in building and construction has initially focused on issues of limited resources especially energy, and on how to reduce impacts on the natural environment with emphasis on technical issues such as materials, building components, construction technologies and energy related design concepts. The appreciation of the significance of non-technical issues (soft issues) has grown, giving recognition to economic and social sustainability concerns as well as cultural heritage of the built environment as being equally important. Presently, the concept of sustainable construction governs three main pillars: environmental protection, social well-being and economic prosperity (A. Abolore, 2012).

3 Research Methodology

The methodology adopted for the study started with understanding the vernacular construction techniques in three agro climatic zones of Vidarbha region. Case studies were identified from rural settlements. Measured drawings were drawn and the data related to the vernacular features with respect to the construction techniques were collected through the structured interviews from the owner of the selected household. The research process included:

1. Identification of agro-climatic zones within the Vidarbha region.
2. Selection of representative case studies from different climatic zones.
3. Reconnaissance surveys using Google Earth and Google Maps.
4. Visual surveys and site visits.
5. Preparation of measured drawings.
6. Photographic documentation.
7. Structured interviews with household owners.
8. Analysis of spatial organization and construction technologies.
9. Assessment of sustainability parameters.

The overall methodology enabled the systematic documentation and comparison of vernacular construction practices across three agro climatic zones of Vidarbha.

4 Agro Climatic Zones of Vidarbha

As per the agro climatic zone prescribed by AICRPAM, Akola Vidarbha is divided into four zones as per the annual rainfall and the crops harvested (Fig. 2). Vidarbha comprises of eleven districts and is classified into four agro-climatic zones based primarily on annual rainfall patterns. These climatic variations significantly influence settlement patterns, building forms, construction materials, and architectural responses. The four agro-climatic zones are given below.

Table no.1 Agro climatic zones of Vidarbha

Sr. no	Agro Climatic Zone	Annual Rainfall
1	High Rainfall Zone	1250–1750 mm
2	Moderately High Rainfall Zone	1076–1460 mm
3	Moderate Rainfall Zone	900–1200 mm
4	Assured Rainfall Zone	650–700 mm

The present study focuses on three zones:

- Assured Rainfall Zone
- Moderate Rainfall Zone
- High Rainfall Zone

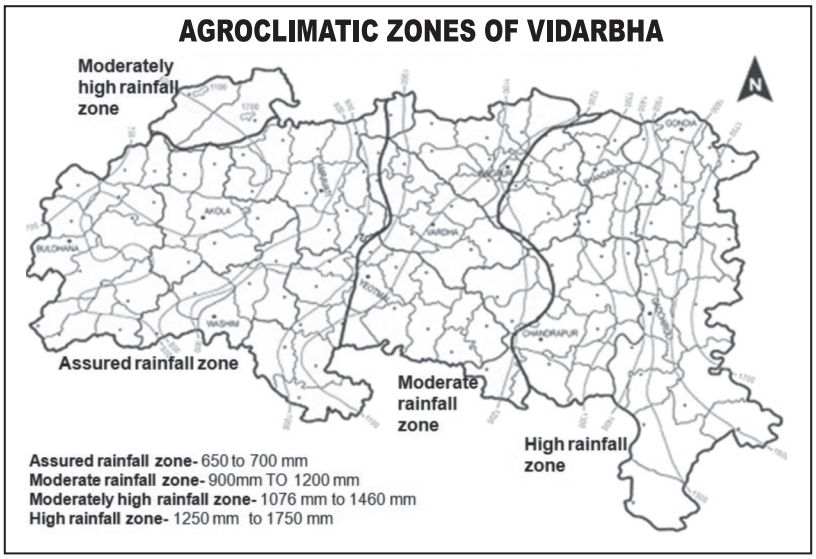


Figure.2 Agro Climatic Zones of Vidarbha (Source: www.mapsofindia.com)

5 Identification of case studies

Case studies were selected from three agro-climatic zones of Vidarbha, namely the Assured Rainfall Zone, the Moderate Rainfall Zone, and the High Rainfall Zone. The Moderately High Rainfall Zone was excluded from the analysis, as it constitutes the smallest unit, confined to the hilly terrain of the Satpuda ranges and comprising only Dharni and Chikhaldara tahsils of Amravati District. This zone is distinguished by elevated altitudes and extensive forest cover, with mean monsoon precipitation of 1006 mm in Dharni and 1337 mm in Chikhaldara.

6 Data Collection

Data collection began with reconnaissance survey to identify villages containing traditional vernacular houses. Satellite imagery and digital mapping tools were used to identify settlements characterized by sloping tiled roofs and traditional layouts. This preliminary assessment was followed by field visits and visual surveys. Houses selected were representative of typical lifestyle, spatial organization and scale based on number of rooms. Documentation included photographs, field notes, measured drawings, material analysis, owner interviews and construction detailsThe information collected during the survey served as the foundation for assessing the spatial organization and construction technologies of the selected household, with particular reference to parameters of sustainability. (Fig.3)

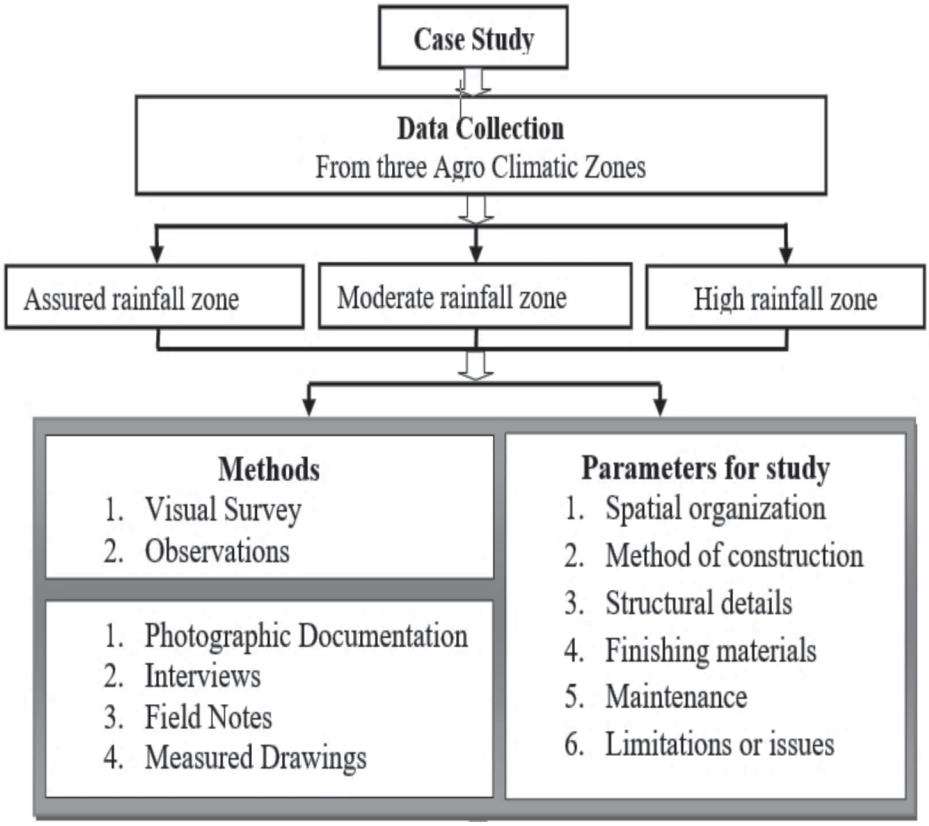


Figure. 3 Framework for data collection

7 Case study from Assured Rainfall Zone, Village - Malegaon (Dist. Amravati) (Fig.4)

Malegaon, a village in Tiwsa Taluka of Amravati District, lies within this agro-climatic zone. It is situated 27 km east of the district headquarters, Amravati, and 16 km from Tiwsa.



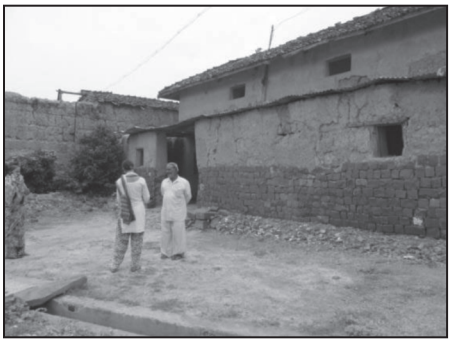
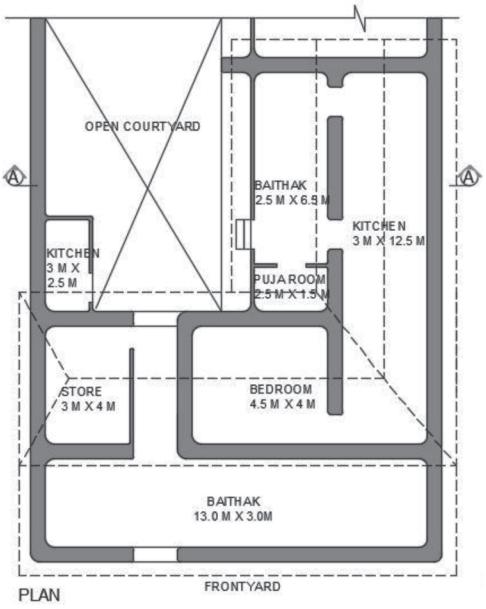


Fig 4: The household in Malegaon Selected for the Study (Source: Author)

Spatial Organization

The selected module represents a large traditional house, locally referred to as a wada, characterized by a central open courtyard. The studied wada comprises seven rooms, including a mezzanine floor used for storage. The spatial layout consists of a drawing room (baithak) with an attached pooja room, a kitchen, a bedroom, a separate kitchen for domestic help, and a front space designated for cattle. Entry through the main door leads directly into the courtyard, which serves as the central circulation space, providing access to the drawing room, kitchen, and bedroom (Fig. 5).





Main entrance



Baithak



Dhaba

Fig 5: The plan and interior spaces of household (Source: Author)

Method of Construction

Technique adopted for walls is cob wall and wattle and daub. The structure is load-bearing, with walls constructed using cob and wattle-and-daub techniques. The main and intermediate walls measure 450 mm in thickness. In the kitchen, cob walls rise to 2.1 m, above which wattle-and-daub construction continues to roof level. Roofing is supported by timber trusses and covered with locally manufactured clay tiles. (Fig.6)

Foundation: The foundation begins at 0.90 m below ground level, with a base width of 0.75 m tapering to 0.50 m at plinth level. Locally available basalt stone in random rubble masonry is employed up to the plinth.

Walling Techniques: Cob walls serve as load-bearing members, while wattle-and-daub is used for partitions. Cob is prepared from elongated mud balls mixed with cow dung and local grass (Pawanya gawat), in a ratio of 3:1:1. Soil excavated from foundation trenches is utilized. Each layer requires six to seven sunny days for drying before subsequent layers are added. Consistency is tested by throwing prepared mud balls against walls from a distance of 3 feet; adhesion without breakage indicates suitability.

Flooring: Ground floors are finished with locally available slate, while mezzanine floors (dhaba) used for agricultural storage employ mud flooring. Wooden beams support bamboo layers, which are filled with a cow dung–mud mixture and finished with mud slurry. Natural light enters through small windows and roof gaps.

Roof: The pitched roof, designed with short eaves due to limited rainfall, is supported by timber trusses and covered with locally manufactured country tiles. Basalt stone tile cladding protects the external façade from weathering.

Lintels, Doors, and Windows: Lintels are constructed from locally sourced teak wood. Due to thinner sections, sagging occasionally occurs from wall load and moisture absorption. Doors and windows are also made of treated teak wood. Windows are narrow, limiting natural light and cross-ventilation.

Finishing Materials: Internal plastering employs sieved fine white soil soaked overnight. External plastering is applied in 2–3 layers using a mixture of white soil, cow dung, and wheat straw (3:1:1), soaked for 15–20 hours. To protect against flooding from the nearby river, external walls are clad with local stone tiles up to 1.5 m height.

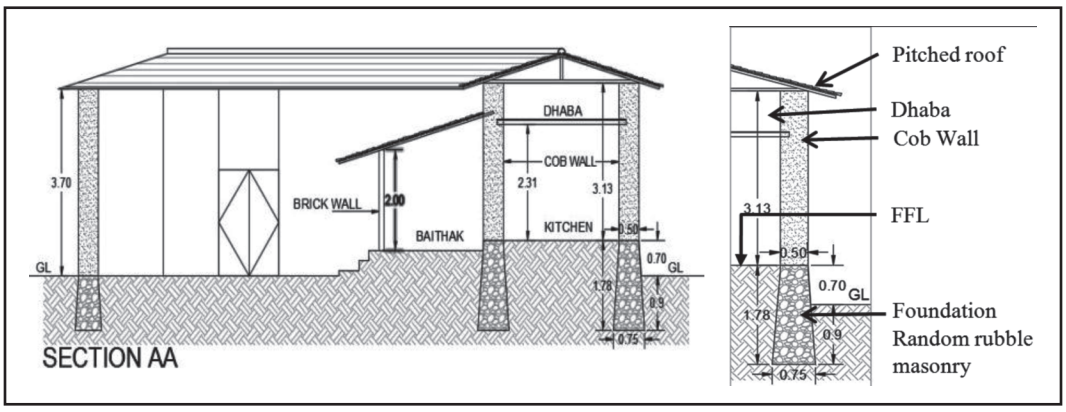


Fig. 6: Sectional details from Foundation to Roof (Source: Author)

8 Case Study from Moderate Rainfall Zone Wadadha Village (Wardha District) (Fig. 7)

Wadadha village is located in Wardha Tehsil of Wardha District (Maharashtra, India). It is situated 8km away from district headquarter Wardha. As per 2009 statistics, Wadadha has the gram panchayat. The selected household comes in the category of big module.



Fig. 7: The household in Wadadha village Selected for the Study (Source: Author)

Spatial Organization

The module comes under the category of big house with five rooms. The elongated space at left hand called as Verandah is used as family space. It comprises of front room with chhapri which is an entrance foyer and baithak which is living area. Other rooms are bed room and kitchen on ground floor and one more bedroom on the upper floor called a majhghar.(Fig 8)

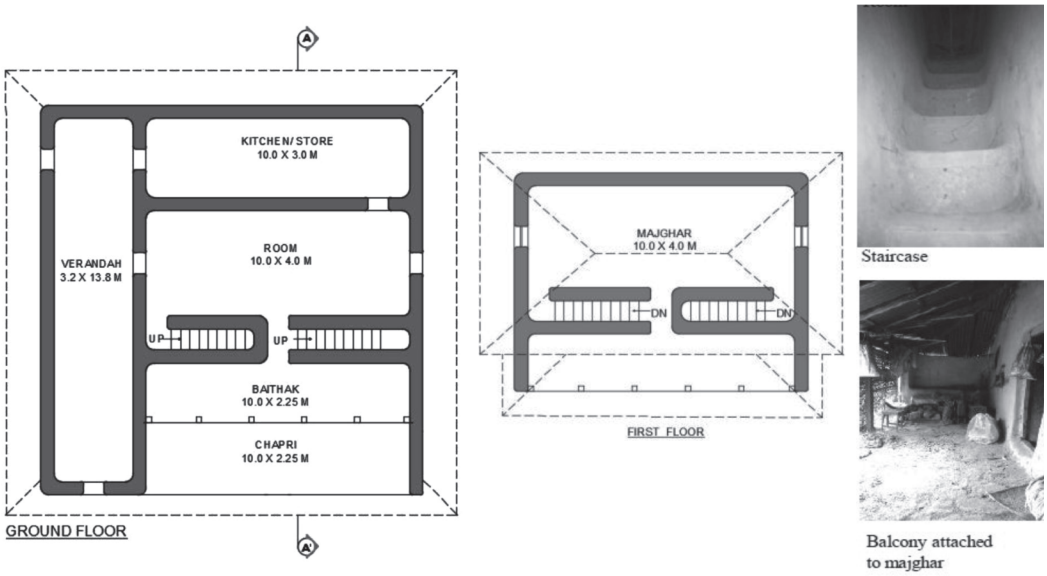


Fig. 8: The Ground Floor Plan and mezzanine floor of selected house (Source: Author)

Method of Construction: Method of construction adopted for wall is cob wall construction technique as all the walls are load bearing with the thickness of 500 mm. Pitched roof with wooden trusses is covered with the locally manufactured country tiles.(Fig 9)

Foundation: The foundation is excavated to a depth of 1.2 m below ground level and constructed using random rubble stone masonry up to 0.3 m above ground level, forming a raised plinth. The foundation tapers from 0.70 m at the base to 0.40 m at the roof level.

Walling: The structure consists of 450 mm thick load-bearing cob walls made from a mixture of locally available white soil, cow dung, and wheat straw. These walls provide structural stability as well as thermal insulation.

Flooring: The flooring is prepared by filling and compacting excavated soil, followed by a finishing layer of soil and cow dung slurry. In the Majhghar, a wooden framework serves as the base, with gaps filled using a mud–cow dung mixture and finished with a smooth coating. Regular maintenance is carried out using cow dung slurry.

Roof: The building has a pitched roof covered with locally manufactured country tiles. The roof is supported by a wooden framework made from seasoned and termite-treated timber. Wooden columns also support the Majhghar floor.

Lintels, Doors, and Windows: Lintels are constructed using locally available timber planks. Doors and windows are made from local timber; however, the limited number of openings results in poor daylight penetration and inadequate cross-ventilation. Despite this, the building maintains comfortable indoor temperatures during both summer and winter.

Finishes: The internal and external wall surfaces are plastered with a mixture of local soil and cow dung. Interior walls are finished with lime wash and locally available pigments, while the exterior walls are left with a simple plaster finish.

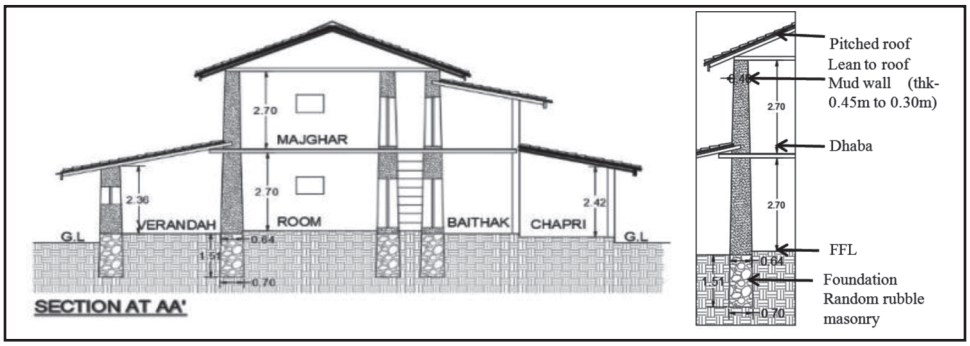


Fig. 9: Sectional Details from Foundation to Roof (Source: Author)

9 Case study from High Rainfall Zone, Village-Zullar Dist Nagpur (Fig.10)

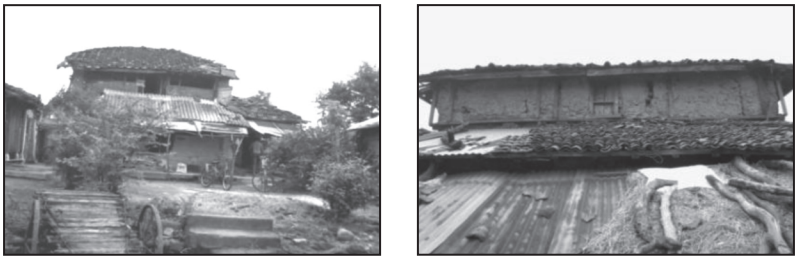


Fig.10: The household in Zullar village Selected for the Study (Source: Author)

Zullar is a village in Mouda Taluka in Nagpur District of Maharashtra State, India. It belongs to Nagpur Division of Vidarbha Region. It is located 30 km towards east from district headquarters Nagpur 14 km from Mouda. The residential module selected for the study comes in big category. The house selected is the representative modules, studied and analyzed in detail through various parameters. (Fig.10)

Spatial Organization: The house is a large traditional dwelling with both front and rear courtyards. It is a two-storey structure comprising a chhapri (entrance foyer), baithak (living area), granary, bedroom, kitchen, washing area, and a wide circulation passage on the ground floor. The chhapri and baithak are separated by a level difference, while the kitchen and washing area are located parallel to the baithak. The granary is filled from the first floor and accessed through a small outlet on the ground floor. A mud staircase with uneven risers connects the two levels. The first floor is mainly used for storage and sleeping, with rooms opening towards the front courtyard and providing pleasant views of the surroundings. (Fig.11)

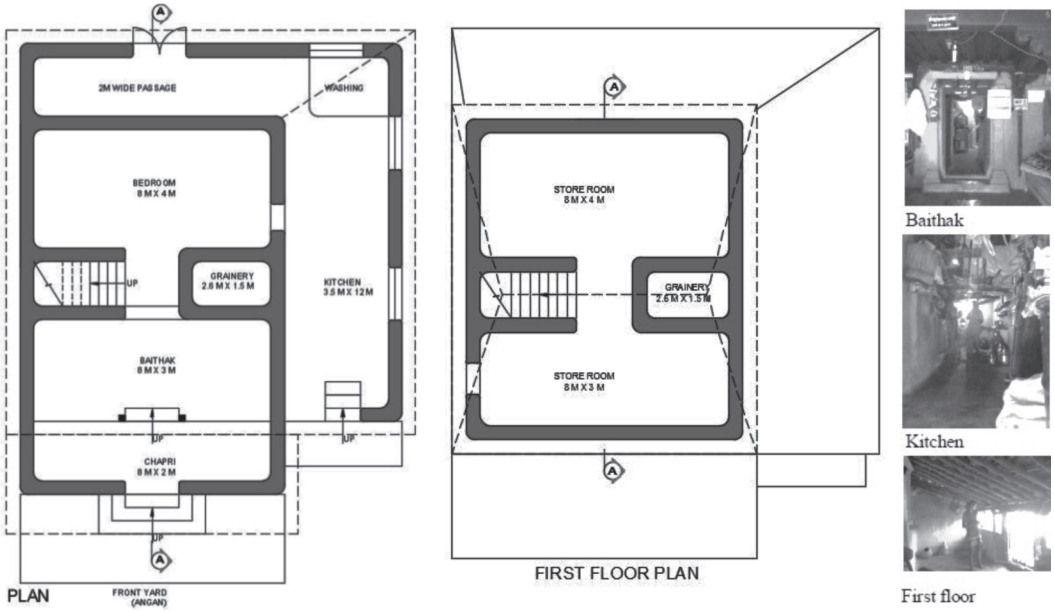


Fig. 11: The Ground Floor Plan and mezzanine floor of Selected House (Source: Author)

Method of Construction

Cob wall construction technique is used for load bearing walls, whereas the front room on the upper floor is constructed with wattle and daub construction technique due to its light weight.(Fig.12)

Foundation: The foundation begins 0.60 m below ground level and rises 0.75 m above ground to form the plinth. Constructed with locally available stone masonry, it is 0.70 m wide at the base and 0.45 m thick at plinth level. The raised plinth protects the structure from rainwater and flooding.

Walling Techniques: Load-bearing cob walls are constructed using white soil, cow dung, and rice husk. Wall thickness tapers from 0.45 m at plinth level to 0.30 m at roof level. Wattle-and-daub construction is used for the upper front wall.

Flooring: The ground floor consists of compacted soil and stone layers finished with a mixture of soil and cow dung, requiring regular maintenance. The first floor has a timber floor made of wooden beams and planks finished with mud, rice husk, and cow dung mortar.

Roofing: The house has a pitched roof supported by seasoned, termite-treated timber trusses. Local country tiles are used as the primary roofing material, with GI sheets added in some areas for protection during the rainy season.

Lintels, Doors, and Windows: Lintels, doors, and windows are made from locally available timber, mainly teak. Small windows and low-height doors with carved wooden frames are used, resulting in limited daylight and darker interior spaces.

Finishing Materials: Walls are plastered with a mixture of local soil, chopped rice husk, and cow dung. Interior surfaces are finished with lime wash and local pigments, while exterior walls are left with a simple plaster finish.

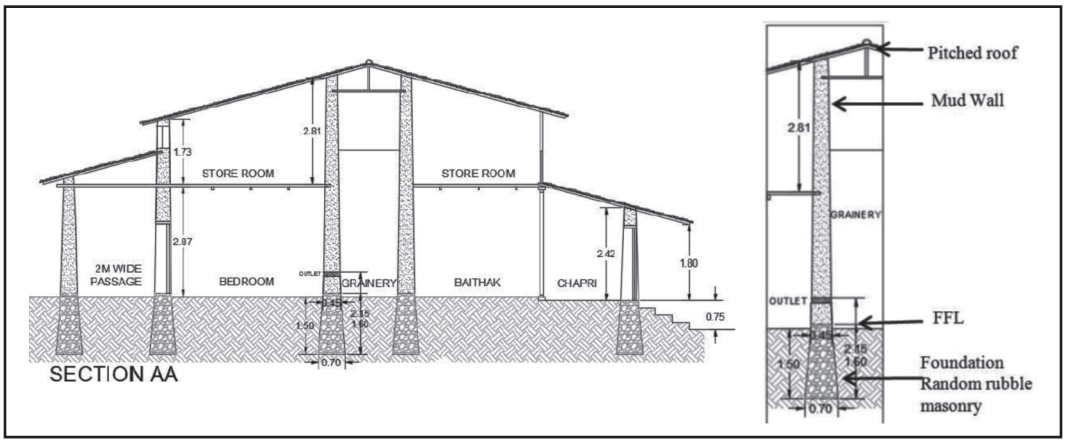


Fig. 12: Sectional Details from Foundation to Roof (Source: Author)

10 Discussion

The comparative study of the three rainfall zones reveals both similarities and climatic adaptations in vernacular construction. All houses belong to the large residential category and include common spaces such as the chhapri (entrance lobby), living area, kitchen, and bedrooms. The assured rainfall zone includes additional spaces such as a pooja room and store room, while the moderate rainfall zone features a baithak, verandah, bedrooms, kitchen, and store. Houses in the high rainfall zone are generally two-storeyed with front and rear courtyards, incorporating a chhapri, baithak, granary, kitchen, and washing area on the ground floor, with storage spaces on the upper floor.

Random rubble basalt stone masonry is used for foundations in all zones, with foundation depth increasing from assured to high rainfall regions. Cob wall construction is commonly adopted for external walls, while wattle-and-daub is used for internal partitions. Wall thickness is greatest in the high rainfall zone, and local soil, cow dung, and agricultural waste are widely used as stabilizing materials.

Flooring techniques are similar across all zones, consisting of compacted earth finished with a soil–cow dung mixture, though maintenance frequency varies. Pitched timber roofs are common, with steeper slopes and longer eaves observed in high rainfall areas. Small timber openings, wooden lintels, and treated timber joinery are used throughout. Walls are finished with plaster made from local soil, cow dung, and agricultural fibers, followed by a final coat of fine clay.

11 Result and conclusion

The vernacular construction techniques observed across all three rainfall zones are inherently sustainable, relying on locally available natural materials and climate-responsive design principles. The use of earth, stone, timber, cow dung, and agricultural waste minimizes environmental impact, conserves resources, and maintains ecological balance. Features such as thermal mass, natural ventilation, daylighting, and pitched roofs enhance energy efficiency while reducing dependence on mechanical systems. Beyond environmental benefits, these techniques preserve local identity, traditional knowledge, and cultural values through community-based construction practices and region-specific spatial planning. By integrating environmental, social, cultural, and economic aspects, vernacular architecture demonstrates a holistic and sustainable approach to building design.

Acknowledgement

The author sincerely acknowledges the contribution of the owners of the residential houses selected from the three agro-climatic zones. Their valuable knowledge and insights greatly assisted in understanding and documenting vernacular architectural practices. This study forms a part of the author's Ph.D. research work.

REFERENCES :

- Asquith, L., & Vellinga, M. (2005). Vernacular architecture in the twenty-first century. Taylor & Francis.
- Brunskill, R. W. (1981). Traditional buildings of Britain: An introduction to vernacular architecture. Gollancz.
- Edwards, B. (2005). The rough guide to sustainability (2nd ed.). RIBA Enterprises Ltd.
- Ganguly, R. (2015). Role of vernacular architecture of India in green building design: A case study of Pauni. International Journal on Recent and Innovation Trends in Computing and Communication, 3(2), 130–135.
- Houben, H., & Guillaud, H. (1994). Earth construction: A comprehensive guide. Intermediate Technology Publications.
- Mockbee, S. (n.d.). Rural Studio undergraduate program of the School of Architecture, Planning and Landscape Architecture at Auburn University. Auburn University.
- Niroumand, H., Zain, M. F. M., Jamil, M., & others. (2013). Assessing critical parameters on earth architecture and earth buildings as vernacular and sustainable architecture in various countries. Renewable and Sustainable Energy Reviews, 28, 130–165. https://doi.org/10.1016/j.rser.2013.07.016
- Rapoport, A. (1969). House form and culture. Prentice-Hall.
- Roy, S., & Chowdhury, S. (2013). Earth as an energy efficient and sustainable building material. International Journal of Chemical, Environmental & Biological Sciences (IJCEBS), 1(2).
- Singh, P., & Yadav, R. K. (2014, May). Effect of marble dust on index properties of black cotton soil. International Journal of Research in Engineering and Technology (IJRET), 3(Special Issue 6).

Bio-Climatic Building Design Strategies for Nagpur Region: A Mahoney Table-Based Approach

Sneha Bodhankar[1], Neeta Lambe[2]

[1] Research Scholar and Assistant Professor, Smt. Manoramabai Mundle College of Architecture, Nagpur, India
[2] Principal, Smt. Manoramabai Mundle College of Architecture, Nagpur, India

Abstract

Rapid urbanization and increasing temperatures have driven the need for climate-responsive architecture in Indian cities. Nagpur, located in the composite climatic zone of central India, experiences extremely hot summers, humid monsoons, and mild winters, resulting in high cooling energy demands. This study demonstrates the Mahoney Tables, a climatic analysis tool developed by Carl Mahoney and widely adopted by the United Nations for tropical building design, to derive bioclimatic design recommendations for Nagpur. Climatic variables including temperature, relative humidity, rainfall, and prevailing wind conditions are analysed to determine design indicators and corresponding passive strategies. The results show that passive building strategies, such as appropriate layout, building orientation, courtyard planning, thermal mass, shading devices, and natural ventilation, will improve thermal comfort while reducing dependence on mechanical cooling. The study concludes that Mahoney Table-based design offers an effective framework for sustainable building design in Nagpur's composite climate.

Keywords : Bioclimatic Design, Mahoney Tables, Composite Climate, Passive Cooling Strategies, Sustainable Architecture, Nagpur region.

Introduction :

India has been addressing climate change through national policies, and the United Nations supports global action with its own policy measures. Because the building sector consumes a large share of energy, integrating energy efficiency and conservation into building design is essential for sustainable development. Bio-climatic design strategies can significantly reduce energy use and also challenge shaping buildings in response to sun, wind, humidity, rainfall, and seasonal temperature variation, so that indoor comfort can be achieved with reduced dependence on mechanical systems (Iberdrola, 2021; Moeve Global, 2025). Passive strategies such as building orientation, shading, controlled fenestration, thermal mass, and natural ventilation have been widely recognized as effective means of reducing heat gain and improving comfort in warm climates (Krishan et al., 2001; Olgyay, 1963). In composite climates, the designer must balance opposing seasonal demands, since measures that are beneficial during hot-dry and warm-humid periods may not always suit cool winter conditions (Koenigsberger et al., 1975; Poudyal et al., 2021).

Nagpur presents a relevant case for this analysis because of its distinct seasonal variation and continued urban expansion (District Nagpur, n.d.). The city experiences hot summers, a humid monsoon, and cool winters, making it necessary to balance heat elimination, air movement, thermal storage, and rain protection within the same design framework (District Nagpur, n.d.; India Meteorological Department, n.d.). Building orientation strongly influences a building's energy performance: the right orientation can reduce solar gain in summer and increase it in winter, an important consideration in composite climates such as Nagpur's.

This paper aims to analyse the climatic characteristics of Nagpur and translate them into architectural recommendations using the Mahoney Table method, with an emphasis on layout, spacing, air movement, openings, wall and roof construction, and other external building features (Koenigsberger et al., 1975; Poudyal et al., 2021). Bio-climatic design integrates architectural principles with local

climate conditions to improve building comfort and energy efficiency. Climate-responsive design is not only an environmental concern but also a practical design imperative for architects and planners working in growing urban regions (Iberdrola, 2021; Moeve Global, 2025). The Mahoney Tables provide a methodical approach to translating climatic data into architectural design recommendations and are particularly suitable for warm and composite climates.

2. Aim

To develop climate-responsive building design strategies for Nagpur using the Mahoney Table method.

3. Objectives

- To analyze Nagpur's climatic characteristics using Mahoney Tables.
- To identify climatic stress conditions affecting thermal comfort.
- To derive architectural design recommendations based on Mahoney indicators.
- To propose passive design strategies for energy-efficient buildings and context-sensitive building design layouts in Nagpur.

4. Theoretical Literature Review :

4.1. Bioclimatic Architecture

Bioclimatic architecture is on the principle that building form and envelope should be adapted to the local climate to improve thermal comfort and reduce energy use (Iberdrola, 2021; Moeve Global, 2025). Some bioclimatic theories and design manuals focus on adaptations that must consider solar geometry, wind patterns, humidity levels, and diurnal temperature ranges in an integrated manner (Olgyay, 1963; Givoni, 1998). Contemporary discussions of bioclimatic design will emphasize orientation, solar control, cross-ventilation, insulation, and envelope performance as primary design variables in warm climates. These principles remain highly relevant in India, where climatic diversity requires region-specific responses rather than uniform building solutions.

Research on passive and climate-responsive design has shown that thermal mass, shading, and controlled ventilation are especially valuable in climates with high diurnal variation and prolonged summer heat (Kalla et al., 2025; Sadafi et al., n.d.). Studies on traditional passive solutions in hot regions similarly show that thick walls, shaded openings, protected courtyards, and roof treatments can moderate indoor temperature swings and improve resilience without heavy mechanical dependence (Radhakrishna S., 2012; Traditional Passive Design Solutions, 2022). Such findings reinforce the relevance of envelope-based and form-based design decisions in cities like Nagpur, where climatic stress changes significantly over the year (District Nagpur, n.d.; Koenigsberger et al., 1975).

4.2 Mahoney Table analysis and its applications

The Mahoney Table remains one of the most practical tools for converting climatic data into architectural guidance at the pre-design stage (Koenigsberger et al., 1975; Poudyal et al., 2021). The method records monthly values of maximum and minimum temperature, relative humidity, rainfall, and wind, and then classifies each month in terms of humidity group and thermal stress (Koenigsberger, 1973). This enables designers to identify whether air movement, thermal capacity, rain protection, or cold protection should be prioritized during different periods of the year, thereby structuring design decisions according to climatic logic rather than generic rules (Poudyal et al., 2021).

Recent research shows that Mahoney-based bioclimatic classification can be applied at regional scales to guide housing design strategies. For example, Upadhyay et al. (2023) divided India into six bioclimatic zones using Mahoney-related indicators such as opening sizes and thermal mass, and then validated design strategies through energy simulations that demonstrated improvements in thermal comfort and reductions in cooling loads (Sangeeta S.,

2025). Similarly, Mahoney Tables have been used to improve thermal comfort in different contexts, including hot and humid climates such as Minia in Egypt (Elshafei et al., 2024).

Studies further indicate that adherence to Mahoney principles can significantly enhance thermal comfort, as observed in the architectural practices of Esfahak village in Iran, where traditional building forms correspond closely to Mahoney recommendations (Hosseini, 2022). Evaluations of campus buildings at the Kwame Nkrumah University of Science and Technology (KNUST) revealed that older structures largely adapted to such principles, whereas constructions often fell short, underscoring the need for consistent bioclimatic design application (Koranteng et al., 2015). These examples suggest that the Mahoney Tool offers a structured approach to bioclimatic design whose effectiveness depends on local practices and on the ability of architects and engineers to integrate its strategies into contemporary construction technologies. Nagpur therefore permits study, because its composite climate demands an integrated response rather than a single-season strategy.

4.3 Climatic zones of India and the composite category

The climatic classification of India has evolved in response to the need for detailed guidelines for thermal design (Koenigsberger et al., 1974). The composite climate category is for design because it combines contradictory seasonal demands (Bansal et al., 1994). A building in such a climate may require protection from intense solar heat during summer, increased air movement during humid periods, and some degree of heat conservation during winter nights, all within a single annual cycle (Poudyal et al., 2021).

According to IS 372–1978, "Guide for Heat Insulation of Non Industrial Buildings," India was originally classified into four climatic zones: (1) Hot and Arid, (2) Hot and Humid, (3) Warm and Humid, and (4) Cold. Later, some inconsistencies in that zoning were noted, and the Central Building Research Institute (CBRI), Roorkee, was asked to reclassify Indian climates. Their research focused on the two climatic factors most affecting thermal comfort: air temperature and humidity, and to identify the extremes of these factors that cause discomfort.

Based on studies, India is now commonly described using four main zones (1) Hot Dry, (2) Warm Humid, (3) Cold, and (4) Temperate, with a sub category: the Composite zone. A location is assigned to a specific climatic zone if its defining conditions persist for more than six months; otherwise it is classified as composite. Table 1 summarizes the updated climatic zones and their characteristics shown in Fig. 1 (Jain, K., 2022).

Table 1: Indian Climatic zones and their characteristics, as per CBRI, IIT ROORKEE, shown in Fig. 1

Climatic Zone	Maximum Temp. (c)	Relative Humidity (%)
Hot Dry	Above 30	Below 55
Warm Humid	Above 30	Above 55
Composite	Above 25	Above 75
Temperate	Between 25-30	Below 75
Cold	Below 25	All Values

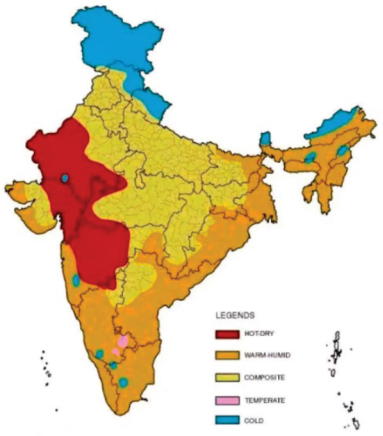


Fig. 1 India Map showing climatic zones

5. Study Area: Nagpur

Nagpur is situated in Maharashtra, India, at approximately 21.15°N latitude and 79.09°E longitude, with an elevation of about 310 m above mean sea level. The city falls within the Composite Climate Zone as defined by Indian climatic classifications (IMD).

5.1 Climatic Characteristics

Nagpur experiences a wide range of climatic conditions over the year. It is characterized by very high summer temperatures, moderate to high humidity during the monsoon, and relatively mild winters. The maximum summer temperature typically reaches about 45–47°C, indicating very hot summers. In contrast, the minimum winter temperature drops to around 10–12°C, reflecting relatively cool but not severe winters. The city receives approximately 1100 mm of rainfall annually, suggesting a moderate to high level of precipitation. Relative humidity varies considerably, from about 20% in the driest periods to nearly 85% in the more humid months. Taken together, these parameters indicate that Nagpur falls under a composite climate type, with conditions that shift markedly between hot-dry and warm-humid phases rather than remaining constant throughout the year.

Table 2: Climatic Data of Nagpur. Source- Climate.org and IMD

Months →	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C	21.1 °C	24.3 °C	28.5 °C	33.1 °C	35.6 °C	31.3 °C	26.7 °C	26.1 °C	26.7 °C	26.1 °C	23.7 °C	21.2 °C
Min. Temperature °C	14.5 °C	17.5 °C	21.2 °C	25.7 °C	29.5 °C	27.3 °C	24.5 °C	23.9 °C	23.6 °C	21 °C	17.5 °C	14.7 °C
Max. Temperature °C	27.7 °C	31.1 °C	35.5 °C	40 °C	41.7 °C	35.8 °C	29.6 °C	29 °C	30.4 °C	31.3 °C	29.7 °C	27.7 °C
Rainfall mm	14	12	17	8	13	169	355	309	168	46	11	6
Humidity (%)	47%	41%	31%	24%	25%	52%	79%	83%	78%	62%	53%	49%
Rainy days	1	2	2	2	2	10	17	17	12	4	2	1
Avg. Sun hours	9.5	10.1	10.7	11.3	11.8	10.7	8.2	7.6	8.7	9.7	9.6	9.5

Table 2 Values are based on IMD climatological tables for the Nagpur observatory, referring to climate.org. Nagpur falls within the composite climate category because no single climatic condition dominates for more than half the year; its annual cycle includes hot-dry months, humid monsoon months, and comparatively cool winter periods (District Nagpur, n.d.; IMD, n.d.). This makes Nagpur an appropriate case for testing bioclimatic design recommendations at the city scale.

6. Research Methodology-Mahoney Table for Nagpur

Research Fig. 2 follows the Mahoney Table methodology, which converts monthly climatic data into design recommendations through a sequence. Mahoney Table is a series of four tables invented by C. Mahoney, a tool for climatic data analysis. Analytical tables showcase location-specific climate data records

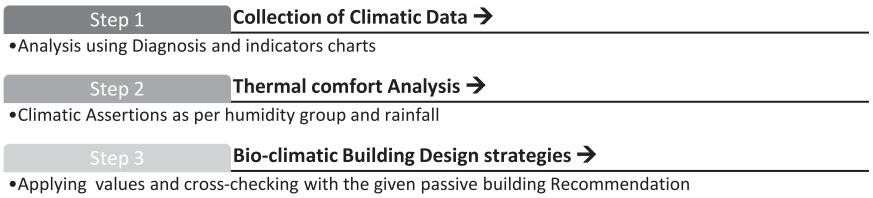


Fig 2. Mahoney table steps of formulating sustainable strategies

of temperature, humidity, and rainfall, which will be diagnosed using indicators and assertion charts, for day-night thermal comfort and stress. This analysis is then synthesised for further recommendations for building design purposes.

Table 3: Nagpur Location data

Location	NAGPUR
Longitude	79.90°E
Latitude	21.90°N
Altitude	310.5 m

Air Temperature °C°

	J	F	M	A	M	J	J	A	S	O	N	D
Monthly Mean maxi. °C	28	31	36	40	42	36	30	29	30	31	30	28
Monthly Mean min. °C	14	17	17	21	26	29	27	24	24	21	17	15
Monthly Mean Range	14	14	19	19	16	7	3	5	6	19	13	13

Relative Humidity: %

	J	F	M	A	M	J	J	A	S	O	N	D
Monthly Mean maxi. °C	80.5	92.4	87	48.8	41.9	97.6	97.5	97.3	94.1	87	83.4	99.3
Monthly Mean min. °C	24.5	27.5	17.3	14.5	13.8	30.8	41.5	54.4	48.5	38.9	33	30.1
Average %	52	60	70	34	28	64	69	76	72	63	58	64
Humidity Group	3	3	3	3	1	3	3	4	4	3	3	3

Rainfall (mm) and Wind Directions

	J	F	M	A	M	J	J	A	S	O	N	D	Total
Rainfall mm	14	12	17	8	13	169	355	309	168	46	11	6	1128
Wind, Preventing	NE	NE	SW	SW	SW	SW	SW	SW	SW	NE	NE	NE	
Wind, Secondary	NW	E	SE	NW	W	W	W	SE	NE	SW	N	N	

Based on IMD climatological normals, Nagpur has a tropical monsoon climate with hot summers, a heavy rainy season, and a mild winter. The year starts with a cool and dry Winter (Jan–Feb), bringing pleasant nights around 13°C and light breezes from the northeast. This leads into a roasting, dry Summer (Mar–May) where temperatures shoot up to a blistering 43°C in May and winds turn south-westerly. Relief arrives with the Monsoon (Jun–Sep) as strong south-westerly winds bring heavy rains and high humidity, nearly 87% of the year's total rainfall, with July being the wettest month. Finally, the Post-Monsoon months (Oct–Dec) see a short spell of October heat before the winds flip back to the northeast, clearing the skies and drying up the weather just in time for winter. Nagpur receives an average annual rainfall of appr. 1,064 mm to 1,225 mm. Over 85% of Nagpur's annual rainfall occurs during the Southwest monsoon months from June to September, with July and August being the wettest months. The dominant prevailing wind direction year-round is Southwest (Primary), driven by the monsoon. The secondary prevailing wind direction is Northeast (Post-Monsoon/Winter).

Fig.3 Standard Acceptable Comfort Limits chart-

Average Mean range		AMT (ave 20°C)		AMT (1.5-20°C)		ATM under 15°C	
AVG. RH	HG	Day	Night	Day	Night	Day	Night
0-30%	1	24-34	17-25	23-32	14-23	21-30	12-21
30-50%	2	25-31	17-24	22-30	14-22	20-27	12-20
50-70%	3	23-29	17-23	21-28	14-21	19-24	12-19
>70%	4	22-27	17-21	20-25	14-20	18-24	12-18

Thermal Stress Analysis was done in Mahoney Tables using the comfort limit chart Fig. 3 and humidity group to determine whether daytime and nighttime conditions produce heat stress, comfort, and Cold stress. Table 3 is primarily used for the diagnosis of the climatic data.

Table 4: Diagnosis

Month	J	F	M	A	M	J	J	A	S	O	N	D
Monthly Mean maxi.	28	31	36	40	42	36	30	29	30	31	30	28
Day Comfort upper	33	31	33	33	35	35	33	33	33	33	33	31
Day comfort lower	29	25	29	29	31	31	27	27	27	27	27	25
Monthly mean min.	14	17	17	21	26	29	27	24	24	21	17	15
Night comfort upper	33	33	33	33	34	34	31	31	31	31	33	33
Night comfort lower	37	37	37	37	37	37	37	37	37	37	37	37
Thermal Stress Day	O	O	H	H	H	H	H	H	H	H	H	O
Thermal Stress Night	C	C	O	O	H	H	H	H	H	H	O	C
	3	3	3	3	1	3	3	4	4	3	3	3

The thermal stress is marked referring to the following abbreviations as –

H- Hot if mean is above limit, O- (Comfort) if mean is within limit, C-(Cold) if mean is below Limit.

Fig.4. Key of Assertion chart-

Applicable when:		**Thermal Stress**		**Rainfall**	**Humidity Group**	**Monthly mean range**
Meaning	Indicators	Day	Night			
Air movement essential	H1	H			4	
		H			2,3	Less than 10
Air movement desirable	H2	O			4	
Rain protection necessary	H3			Over 200 mm		
Thermal capacity necessary	A1				1,2,3	More than 10
Outdoor sleeping desirable	A2		H		1,2	
		H	O		1,2	More than 10
Protection from cold	A3	C				

Nagpur Assessment shows Summer has severe heat stress during the day and moderate heat stress at night. Monsoon shows Heat stress during the day and comfort at night. Winter has comfortable days and Mild cold at night. The Key Assertion chart maps thermal comfort throughout the year as per season changes, shown in Fig. 4; it is guided by the humidity group, indicating thermal stress during the day and night, desirable for conditions such as Air movement, rain protection and protection from cold, desirable or not. This analysis indicates that heat stress dominates most of the year, making solar protection and ventilation the primary design objectives as per Diagnosis Table 4.

Table 5 -Indicator chart

Month	J	F	M	A	M	J	J	A	S	O	N	D	Total
Humid: H1						✓	✓	✓	✓				4
Humid: H2													0
Humid: H2							✓	✓					2
Arid: A1		✓	✓	✓	✓					✓	✓		6
Arid: A2				✓	✓								2
Arid: A3													0

Table 5 defines six indicators calculated referring to Table 4 and Fig.4. The first three are humid indicators, i.e. H1, H2 & H3, and the next three are arid indicators, A1, A2 &A3. Procedure for tabulating Table 6 is to check the monthly mean range, humidity group, rainfall from Tables (2, 3 & 4) and thermal stress values from Table 4 and place a tick mark in the line of the appropriate indicator. In the last column, write the total number of ticks corresponding to a particular indicator.

Table 6 : Indicator total from Table 6 total from

H1	H2	H3	A1	A2	A3
4	0	2	6	2	0

The Procedure for tabulating Tables 7 and 8 is to transfer the indicator totals from Table 6 to the first line. Place a tick mark against the specification item in the same line as the indicator values.

Table 7 : Recommended specifications

Indicator total from Table 7					
H1	H2	H3	A1	A2	A3
4	0	2	6	2	0

Layout

1	Orientation north – south (long axis east-west)	✓			0-10			
					11,12			4-12
2	Compact courtyard planning	✓			11,12			0-4

Spacing

3	Open spacing for breeze penetration		11,12					
4	As 3, but protection from hot and cold wind	✓	11,12					
5	Compact lay-out of estates		0-1					

Air Movement

6	Rooms single banked, permanent provision for air movement	✓	3-12					
			1,2			0-5		
7	Double-banked rooms, temporary provision for air movement					6-12		
		✓	0	2-12				
8	No air movement requirement	✓		0-1				

Openings

9	Large openings, 40-80%				0,1		0	
10	Very small openings, 10-20%				11,12		0,1	
11	Medium Openings, 20-40%	✓			2-12			

Walls

12	Very small openings, 10-12%					0-2		
13	Medium openings, 20-40%	✓				3-12		

Roofs

14	Light, insulated roofs					0-5		
15	Heavy roofs, over 8 hr time-lag	✓				6-12		

Outdoor Sleeping

16	Space for outdoor sleeping required	✓				2-12		

Rain Protection

17	Protection from heavy rain necessary				3-12			

Table-8 Detailed Recommendations

H1	H2	H3	A1	A2	A3
4	0	2	6	2	0

Size of openings

1	Large: 40-80%	✓				0,1		0
2	Medium: 25-40%							1-12
						2-5		
3	Small: 15-25%	✓				6-10		
4	Very Small: 10-20%					11,12		0-3
5	Medium: 25-40%							4-12

Position of Opening

6	In north and south walls at body height on windward side	✓	3-12					
			1,2			0-5		
7	As above, openings also in internal walls					6-12		
		✓	0	2-12				
8	Exclude direct sunlight	✓						0-2
9	Protection from rain	✓				2-12		

Walls and floors

10	Light, low thermal capacity	✓					0-2	
11	Heavy, over 8hr time-lag						3-12	

Roofs

12	Light, reflective surface, cavity		10-12			0-2		
13	Light, well insulated					3-12		
			0-9			0-5		
14	Heavy, over 8hr time-lag	✓				6-12		

External features

15	Space for outdoor sleeping	✓					1-12	
16	Adequate rainwater drainage	✓			1-12			

Table 9 show the specific recommendations for Nagpur Region, referring to Table 7 and Table 8. Table 9 of Mahoney's table formulates the passive strategy recommendations for challenging Nagpur composite climate energy-efficient sustainable building design practices; designers and planners can follow the same to make the building climate responsive, which will contribute to reducing the carbon footprint of the place and provide thermal comfort to users.

This is the Bioclimatic analysis by Mahoney, which shows the design recommendations for energy-efficient, sustainable buildings in the Nagpur Region.

Table 9 showing Specific Recommendations for Nagpur

Parameters	Recommendations
Layout	Building orientation north and south (long axis east –west) to reduce solar radiation incident on the wall, Open spacing with vegetation, Courtyards and shaded verandahs
Spacing	Open spacing for breeze penetration but protection from the hot and cold wind,
Air movement	Rooms shall be single-banked with a permanent provision for air movement. Cross ventilation
Size of Openings	Small- 15-25%, large -40-80% Medium to large with shading
Position of openings	In north and south walls at body height on windward side
Protection of openings	Exclude direct sunlight
Walls	Heavy, over 8-hour time lag, High thermal mass
Roofs	Heavy, over 8-hour time lag, insulated or reflective
Outdoor sleeping	Space for outdoor sleeping required
External features	Adequate rainwater drainage required
Landscaping	Native trees and permeable surfaces

9. Discussion

The Mahoney Table analysis identifies heat gain as the climatic challenge in Nagpur. Consequently, passive cooling strategies should take precedence over mechanical conditioning. Building orientation and shading reduce direct solar radiation, while thermal mass moderates' indoor temperature fluctuations. Cross-ventilation and courtyards enhance convective cooling during both summer and monsoon periods.

Compared with conventional building design, the Mahoney approach provides a structured decision-making framework that links climatic data directly to architectural form. This enables architects to optimise energy performance during the early stages of design while maintaining occupant comfort.

10. Conclusion

The study reveals that the Mahoney Table methodology is an effective, low-cost decision-support tool for deriving climate-responsive design guidelines for Nagpur's composite climate, particularly at the early stages of building design. By systematically interpreting long-term climatic data (temperature ranges,

relative humidity, and seasonal rainfall), the method translates abstract climatic parameters into architectural strategies adjusted to Nagpur's hot–dry and warm–humid climatic conditions.

The synthesized Mahoney-based recommendations show that climate-responsive performance in Nagpur depends on an integrated approach to site planning, envelope design, and landscape. A north–south building orientation (long axis east–west), open spacing with vegetation, and the use of courtyards and shaded verandahs enhance breeze penetration while protecting occupants from hot and cold winds. Single-banked rooms with permanent provisions for cross ventilation, openings located on the north and south façades at body height, and carefully controlled opening areas (around 15–25% in exposed walls and up to 40–80% where adequate shading is provided) help ensure sufficient air movement without excessive solar gain. Heavy, high–thermal-mass walls and roofs with at least an 8-hour time lag, combined with insulated or reflective roof finishes, contribute to indoor temperature stability and support night-time cooling, while provisions for outdoor sleeping, native tree cover, permeable surfaces, and adequate rainwater drainage further enhance microclimatic comfort and site-level resilience. Taken together, these parameters form a coherent set of passive design guidelines that will be directly applied by architects and planners. This will achieve thermally comfortable, energy-efficient buildings suited to Nagpur's climatic context.

The research also acknowledges key limitations of the Mahoney Table methodology. As an empirical, rule-based tool, it cannot fully represent the dynamic interactions among materials, occupancy patterns, and microclimatic variations, nor the performance of contemporary envelope technologies and mixed-mode ventilation systems. Its outputs should therefore be regarded as a robust first approximation to climate-responsive design rather than a replacement for detailed thermal simulations or field measurements, especially in complex or high-performance building typologies.

Practically, the findings suggest that incorporating Mahoney-derived bioclimatic guidelines into local development control regulations, building by-laws, architectural studio teaching, and professional practice can support more thermally comfortable, energy-efficient, and context-sensitive buildings in Nagpur and similar composite climates. Architects and planners can employ the tables as an initial filter to set orientation, massing, envelope properties, and landscape strategies, and then refine these decisions through advanced simulation tools and performance-based design workflows. Policymakers may draw on the identified passive measures to craft incentives or minimum requirements that mainstream climate-responsive design in both new construction and retrofit projects.

Future research should validate and refine Mahoney-based recommendations through dynamic thermal simulations and post-occupancy evaluations of representative residential, educational, and commercial buildings in Nagpur. Coupling the Mahoney approach with tools such as DesignBuilder and OpenStudio, and benchmarking simulated performance against in situ monitoring, would enable more precise quantification of energy savings, thermal comfort hours, and peak cooling load reductions. Such evidence can reinforce prescriptive yet flexible design standards that link traditional bioclimatic knowledge with contemporary performance-driven practice in composite climates.

REFERENCES :

- Arvind Krishnan, Nick Baker, Yannas and Szokolay, S.V. "Climate responsive Architecture, A design handbook for energy efficient buildings". Tata McGraw-Hill Education, 2001
- Bansal, N.K., Hauser, G. & Minke, G., 1994. Climate-responsive architecture: A design handbook for energy-efficient buildings. New Delhi: Wiley Eastern Limited.
- Bureau of Indian Standards. (2016). National Building Code of India 2016.
- Bureau of Indian Standards. (2017). Energy Conservation Building Code (ECBC) 2017. Bureau of Energy Efficiency.
- District Nagpur. (n.d.). District Nagpur official website. https://nagpur.gov.in
- Elshafei, N. (2024). Title of article on Mahoney Tables in Minia, Egypt.
- Energy conservation building code (ECBC) 2007 from http://www.sgcindia.in/pdf/ECBC_final_May_2007.pdf
- Givoni, B. (1998). Climate considerations in building and urban design. John Wiley & Sons.
- Hosseini, A. (2022). Sustainable case study of Esfahak village.
- Iberdrola. (2021). What is bioclimatic architecture? Iberdrola. https://www.iberdrola.com
- India Meteorological Department. (n.d.). Climatological tables for Indian observatories. IMD.
- Jain, K., Gupta, G., Verma, K.K. et al. (2022). Climatic Classification of India for Building Design Using Data Analytics. Natl. Acad. Sci. Lett. 45, 235–239
- Kalla, R., (2025). passive design and thermal mass.
- Koenigsberger, O. H. (1973). Mahoney Tables: A method of climatic analysis for building design. United Nations Department of Economic and Social Affairs.
- Koenigsberger, O. H., Ingersoll, T. G., Mayhew, A., & Szokolay, S. V. (1974). Manual of tropical housing and building: Climatic design. Longman.
- Koranteng, C., Badu, E., & Addy, M. (2015). Mahoney Tables and campus buildings at KNUST.
- Krishan, A., Baker, N., Yannas, S., & Szokolay, S. (2001). Climate responsive architecture: A design handbook for energy efficient buildings. Tata McGraw-Hill.
- Moeve Global. (2025). Bioclimatic design strategies for sustainable architecture. https://www.moeveglobal.com
- Olgyay, V., & Olgyay, A. (1963). Design with climate: Bioclimatic approach to architectural regionalism. Princeton University Press.
- Poudyal, S., Author, A., & Author, B. (2021). Application of Mahoney Tables in composite climates.
- Radhakrishna S., 2012. Evaluation of traditional architecture in the coastal region of Nagappattinam using Mahoney tables. Journal of Applied Sciences Research, 8(1), pp.582–588.
- Sadafi, N., Author, A., & Author, B. (n.d.). Traditional passive design solutions in hot regions.
- Sangeeta, S., 2025. Climate-responsive design: a comparative study using Mahoney table across diverse Indian climates. International Journal for Research in Applied Science & Engineering Technology (IJRASET), 13(4), pp.187–201.
- Traditional Passive Design Solutions. (2022). Traditional passive design solutions in hot climates..
- Upadhyay, R., Author, A., & Author, B. (2023). Bioclimatic zoning of India based on Mahoney strategy.

Research Journal

Call for Papers

Research papers, research articles, research accounts, review articles, book reviews, research news, commentary, communication, etc. on the subjects from the Faculties of Arts, Social Sciences and Commerce are invited for the publication in the **Research Journal Vol. 21, NO. (2)2025.**

The articles may be sent as an e-mail attachment in MS-Word as printed/typed copy on or be-fore **15th June 2025** at the following address: **The Convenor, Research Development Cell, L.A.D. and Smt. R. P. College for Women, Nagpur - 440 010. Or mail to the email given on the website in the contact us tab under Research Publications.**

GUIDELINES FOR CONTRIBUTORS

Two issues of Research Journal are published every year. Of these, the first issue covers research papers pertaining to Science, Social Sciences and Com-Commerce and the second issue incorporates research papers from Home Science, Applied Electronics, Cosmetic Technology, Hotel Management and Catering Technology, Interior Designing and research topics of interdisciplinary studies.

Manuscript Preparation : Papers must normally present results of original work. Reviews and articles based on important fields and emerging areas will also be considered for publication. Submission of the script will be held to imply that it has not been previously published and is not under consideration for publication elsewhere and further that, if accepted, it will not be published elsewhere. The guidelines for contribution are given in the journal. The format for contributors given in the journal should be submitted along with the manuscript. The decision of the Editorial board will be final for selection of the paper for publication. For any other information, contact: The Convenor, Research Development Cell. L.A.D. and Smt. R. P. College for Women, Nagpur.

Papers should be typed in double space on one side of the white paper. Pages should be numbered starting from the title page, text of the paper, references, tables and figures. The title page should include the title of the paper, name/s of author/s and the name of the institution/s. The name of the author should not ap-pear anywhere else in the paper. The paper should include:

1. **Title :** It should be short and expressive and should contain words suitable for indexing.

2. **Abstract :** All papers must have an abstract of between 150- 200 words, should convey main points of the paper, outline the result and conclusions. Presentation of numerical results should be avoided in the abstract.

3. **Key words :** About 3-5 keywords should be provided for indexing and information retrieval. Phrases of several words should be avoided.

4. **Text :** All papers should have a brief introduction. The text should be intelligible to readers in different disciplines. All technical terms, symbols and abbreviations should be defined. In case of scientific papers, the units of measures should be either metric or Sl. Tables must be numbered in Arabic numerals in their order of appearance in the text. Reference for table number or figure number must be depicted in the text. Tables should have descriptive title. Line drawings, figures, should be roughly twice the printed size and submitted in duplicate. Photocopies of photographs should not be submitted. Handwritten symbols and equations should be avoided as far as possible. Spelling of the symbols may be typed and provided in brackets along with the symbol at the end of the paper on a separate sheet.

The text should incorporate the following details:

I) Brief introduction focusing on literature and scope of study

ii) Subheads at appropriate places such as materials and methods, observations, results, discussions or result and discussion, conclusions, etc.

iii) Illustrations that will help general readers.

5. References : References should be numbered in text , serially in the order in which they appear through the text followed by tables and figures. List of references at the end of the text should be in the following format:

Sr. No.. Name of Author, (year of publication). Title of paper, Title of Journal, **Vol:, No., p.p.**

Illustration

Zachmann, E. J. and Molina, E.A.J. (1993) Presence of Culturable Bacteria in Cocoons of the Earthworm Eisenia Fetida. Applied and Environmental

Microbiology, Vol. 59 No. 6 pp 1904-1910.

Reference to books should include name(s) of author(s), initials, (year of publication), title of the book, edition, initials and name(s) of editors, if any, place of publication, publisher and chapter or pages referred to.

References to report and unpublished conference proceedings should include title of the report/paper.

References to Theses must include title of thesis, degree for which submitted, the name of the university and city where it is located.

6. Acknowledgement : Author may acknowledge the help received during the course of investigations in 2-3 lines at the end of references.

7. The word limit for various contributions :

General Articles	:	2000 - 5000 words
Review Articles	:	3500 – 3500 words, excluding abstract and cited references
Research Paper	:	3500 - 6000 words
Research Account	:	2500 – 3500 words, excluding cited references
Research Articles	:	2000 – 4000 words
Book Review	:	1500 - 2000 words
Research Communication	:	500 – 1000 words

Declaration

The Research Paper / Article entitled _____

_____

_____

Contributed by me/us for publication in the Research Journal is my own original work. It has not been sent for publication in any other research journal.

Date:-

Signature of Author

Name:-

Designation:-

FORMAT FOR SUBMISSION OF RESEARCH PAPER / ARTICLE

Title of Paper _____

Name of Contributor _____

Institutional Address _____

_____

Ph. Nos. _____ E-mail _____

Residential Address _____

_____

Ph. No. (Resi.) _____ (Off.) _____ (Mob.) _____

Post Held _____

Qualifications _____

Publications _____

_____

Any other (awards, citations etc.) _____

Abstract of paper in not mare than 200 words (MS word) _____

_____

_____

_____

_____

_____

_____

_____

The research paper/article entitled _____

_____

contributed by me/us for publication in the Research Journal is my own original work. It has not been sent for publication in any other research journal.

Encl. : Two copies of manuscript of paper & CD.

Date: _____

Signature of author

Name _____

Designation _____

Panel of Reviewers

Research Journal, Volume 20, No. (2), 2024 (ISSN 0974 - 0317)

1. Dr. A.M. Ittadwar	Principal, Gurunanak College of Pharmacy, Nari, Nagpur
2. Dr. A.S. Muktibodh	HOD of Mathematics, Mohota Science College, Nagpur
3. Dr. C.V. Dhuley	Ex-Head, Dept. of Electronics, Dharampeth M.P. Deo Memorial Science College, Nagpur.
4. Dr. Aruna Kawadkar	Asst. Professor, Dept. of Zoology, Institute of Science, Nagpur
5. Dr. Arun Ingle	Associate Professor, Dept. of Microbiology, Seth Kesrimal Porwal College, Kamptee.
6. Dr. Y. Deshpande	HOD of Social Science & Humanities, V.N.I.T., Nagpur
7. Dr. R. Sharma	Associate Professor, Academic Staff College, R.T.M. Nagpur University, Nagpur.
8. Dr. J. Kashikar	Associate Professor, Dept. of Home Science, Extension Yeshwant Mahavidyalaya, Wardha.
9. Dr. Bhawana Sharma	HOD of Textile & Clothing, M.H. Autonomous College of Home Science, Jabalpur (M.P.)
10. Dr. Ashok Bhattacharya	Sr. Visiting Faculty, P.G.T.D. Dept. of Tourism Management RTM Nagpur University, Nagpur
11. Dr. Arti Meshram	Head of the Department, GIHMCT, Nagpur
12. Dr. Tutu Sengupta	Associate Scientist, MRSAC
13. Dr. Trupti Dabe	Associate Professor, Department of Design, Manipal School of Architecture and Planning, MAHE, Manipal, Karnataka.
14. Dr. Lakshmi Rao	Professor, SMMCA, Nagpur
15. Dr. Sarika Bahadure	Assistant Professor, Department of Architecture and Planning, V.N.I.T., Nagpur.
16. Dr. Shalini Wankhede	Retired Associate Professor, LAD College, Nagpur.
17. Dr. Shweta R. Suhane	Assistant Professor, Institute of Architecture and Planning, Nirma University nirmauni.ac.in
18. Dr. Vipin Dhote	Faculty of Pharmacy, VNS Group of Institutions, Bhopal.
19. Dr. Sheetal Sharma	Dean and Professor, School of Architecture, VIT, Bhopal University.
20. Dr. Akshay Kaleshwarwar	Assistant Professor, Institute of Architecture and Planning Nirma University Ahmedabad, Gujarat.
21. Dr. Shivanjali Mohite	Assistant Professor, Institute of Architecture and Planning Nirma University Ahmedabad, Gujarat.
22. Dr. Ishwari khatwani	Associate Professor , Head Department of Home Science, S. S. Girls' College, Gondia ishwari369@gmail.com
23. Dr. Swapna Uddhao	Ph.D. (Mathematics), Assistant Professor, Department of Mathematics, L.A.D. & S.R.P. College for Women, Nagpur.
24. Dr. Vaishali Kilor	Associate Professor at Gurunanak College of Pharmacy, Nagpur, M.S.
25. Dr. Shonali Nazare	Materials Research Engineer at National Institute of Standards and Technology (NIST) Rockville, Maryland, United States.
26. Dr. Shilpa Ingoley	Assistant Professor, Computer Engineering, Thadomal Shahani Engineering College(TSEC, BANDRA), Mumbai University
27. Dr. Bhakti Dhawle	Development officer at Tata Trusts, Pune, Maharashtra, India.
28. Dr. Mangal Panchal	Women and Child Development Department, Chatrapati Sambhaji Nagar, Maharashtra.
29. Dr. Pradmya Dakhole	Principal , Smt. Shalinitai Meghe Ayurved Collage, Hospital & Research Centre, Bhilewada, Bhandara
30. Dr. Vishakha Kawathekar	Professor, Department of Conservation, SPA, Bhopal.
31. Dr. Ujwala Bharambe	Associate Professor, (PhD, IIT Bombay) TSES, Bandra, Mumbai.