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Biophilic Impact on Office Microclimate: A Comprehensive Study on Productivity, Health & Wellbeing of Corporate Office Staff

Tusar Kanti Tripathy
Research Scholar, Biju Patnaik University of Technology

ABSTRACT –
Urban settlement world wide have historically been designed with a predominantly male perspective, often neglecting the diverse needs, requirements and experience of a woman. Although women represent a substantial portion of urban population, yet their voices and needs are often marginalized in the planning and designing process. Cities continue to grow and expand at rapid pace, so to cope up the necessity for inclusive urban design to address the diverse needs of all the citizens (particularly women), has become increasingly evident.
This paper explores the concept of female-centric urban design as a paradigm shift towards more sustainable and Inclusive urban development. It aims to emphasis the urgent need for urban planners, architects and policy makers to re-evaluate traditional design paradigm so as to incorporate gender-sensitive perspective into urban spaces
In the urban areas the percentage of open spaces go on decreasing as architects, town planners try to increase the ground coverage under built up area so as to accommodate more people in the limited space. This modern day's compact planning approach with idea of reduced green coverage, open spaces along with increased transportation facility and road network, increase the pollution level of air, water and noise to a higher level. Outdoor spaces if made biophilic will have positive impact on the climate such as better air quality, reduction carbon sequestration and toxic pollutants, natural cooling effect, and increased oxygen level. Also designing for compact interior spaces in the built environment create unhealthy conditions reducing job satisfaction, and productivity among the users in the built space. Poor maintenance of habitable spaces, absence or reduced natural elements and prolonged working hours of employees in IT offices increases their stress levels, employee absenteeism, and sickness. In this context it is very important to make the outdoor spaces of the IT offices biophilic. A survey was conducted to measure the impact of biophilic design of outdoor spaces of IT office complex on the climate of the IT office premise. From the analysis of the responses collected it was found that the biophilic designed outdoor spaces of offices have better climate in comparison to offices with no biophilic designed outdoor spaces.

Keywords: **Absenteeism, Biophilic, Cooling, Pollution, Satisfaction**

INTRODUCTION –

Biophilic design is a practice of utilizing nature-based systems, engineering principles, and design cues to support, improve and enhance health, well-being and performance and imparts positive result on work efficiency and work quality. Biophilic design integrates the contributions of other nature-based design techniques towards a sustainable and climate change resilient growth. Climate change is projected to be the most serious threat to global economic, social and environmental stability, with mild to severe disruptions globally affecting populations with unequal leverage for adaptation, mitigation and resilience (Special Report on Global Warming of 1.5◦C (2018). Intergovernmental Panel on Climate Change (IPCC).).

Climate fluctuations leads to diseases like- cardiovascular mortality, respiratory illnesses even to transmission of infectious diseases and malnutrition from crop failures or ill nutrition. As a result, the populations face significantly increased health challenges in the coming decades; the target group include - children, pregnant women, immuno-compromised adults, obese persons and populations existing in informal communities (slums, refugee camps etc). and that section of the society which lies underserved by traditional social, civic, or healthcare services.

if global temperatures rise by 4 degrees in the next 100 years as predicted by the Intergovernmental Panel on Climate Change (IPCC), there simply won't be time for the metabolic changes needed for most species to successfully adapt (Quintero, I., and Weins, J.J (2013). doi: 10.1111/ele.12144). In case of extreme heat, research indicates symptoms like reduced appetite, diminished functioning of brain, and frequent irritation ; as temperatures increase, the circulatory system endangers the functioning of lung, heart, and brain. Study shows Temperatures

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above 58.3 C/137 F make outdoor activity critically dangerous (potentially fatal) and above 74 C/165 F deadly for even resting under the shade (Hanna, E., and Tait, P.W (2015). doi: 10.3390/ijerph120708034) . Although these extremes temperatures are still relatively rare, but prolonged exposure to heat and humidity may pose significant threats to public health globally.

Carbon dioxide emission is another major cause to rise in temperature. More than 70% global CO2 emissions is attributed to the generation and maintenance of cities; analysis mapping of residential carbon dioxide emissions in top 100 cities account for 20% of humanity's overall carbon footprint (C40 Cities. Retrieved from: https://www.c40.org/other/the-future-we-don-twanthomepage). Main cause of increase carbon footprint is mainly due to destruction of existing carbon sequestration ecologies and inadequate restoration of fallow land limits our ability to recapture ambient atmospheric carbon.

Attempts to use nature and natural features within build environment to innate preferences for materials, forms and sensory cues to support health and wellbeing through ways like – site specific design, align building with its ecology, net-zero and energy positive performances, heat island mitigation, habitat restoration to support biodiversity, water table restoration, planned allocation of open spaces for recreation, refuge and restoration. In addition, research suggests that green space is beneficial for mental health and improves physical wellbeing, counteracting the influence of socio-economic disparities.

Other noticeable outcome of biophillic design is Preparedness form severe natural and man made disasters such as strong storms, floods, and droughts, to be managed by human networks, ecological services, and environmental sensitive planning approach to restore health and safety.

AIM –

Aim of the Research paper is to gain an understanding of and evaluate on the Impact of Biophillia on climate change, productivity, Psychological and Physiological wellness and improved indoor air quality of Corporate Office area.

OBJECTIVE –

1- Provide compressive understanding of biophilic, sustainable and human centric design.
2- Evaluate how biophilic human centric design can help mitigate climate change ill impact and help improve overall wellbeing.
3- Draw inference on positive impact of biophilic design on mitigating climate change and improving personal wellbeing and enhance productivity.

RESEARCH METHODOLOGY –

In order to reach the objective of the study the following research methodology were under taken. –

- Firstly an extensive literature review was done to gain insight into climate change related issues and its impact on human community an a broad scale.
- Secondly several methods of primary research were conducted, including –
  - A targeted survey of IT Office premises to evaluate and access present working conditions and the common blockers that need to be addressed.
  - A target questionnaires to assess if exposure to nature can reduce perceived stress level.
  - Attempts to understand how climate change through biophillia can reduce pollution, mental & physical wellbeing.
- Lastly assessing to determine if and how biophillia can promote climate change, sustainable development and enhance wellbeing among occupants of a IT Office premises.

LITERATURE REVIEW –

Climate change and its Impacts –

Climate change may be described as a longterm shift in earths weather pattern that affects temperature, humidity, wind, cloud cover and precepetation, (UN framework on climate change, 1992). Various impacts of climate change are listed bellow –

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a) Socio-economic Impact – climate change cause significant disaster claiming live and livelihood, , shortage of natural resources (water), devastating coastal ecosystem, causing tsunami, earthquake and landslide. Natural and environmental calamities cause huge loss globally in sectors like food productivity (decrease agricultural output), outbreak of diseases and damage to Infrastructure.
b) Health and wellness – In recent years smoke related pollution has impacted greatly on human wellbeing, smoke related eye and skin disease, rise in road accident due to poor visibility and health related respiratory disorder due to particulate matter.
c) Psychological impact – climate change is responsible for exaggerating spread of certain epidemic, which impact most on the vulnerable section of the society. Living in epidemic like situation makes inhabitants to live in fear and in a constant stressful situation. Climate change results in anxiety, distress and pushing public to live in various psychological related problems.
d) Biodiversity loss – Global biodiversity suffer severely due to climate change impact. Due to sudden change in climatic phenomenon many biodiversity fail to cope to the change and adept to the change resulting in extinct of many variety of biodiversity community.
e) Vector borne diseases and pest outbreak – sudden change in climate to extreme level favour growth and spread of various vector borne diseases which cause damage to food production, Livestock productivity and healthy growth of human community.

Biophillia and Climate change –
With growing environmental challenges, biophillic approach to design has gained widespread attention in architecture and interior design starting from individual scale to community and city scale. In the last decade climate change is the major concern to global economy and social and environmental stability, affecting population with unequal leverage for adaptation, migration and resilience (Special Report on Global Warming of 1.5◦C (2018). Incheon, Republic of Korea: Intergovernmental Panel on Climate Change (IPCC).). climate change has also resulted in rise of global temperature, warming of oceans, melting of polar ice and rise in sea level. This has induced many harmful impact on biodiversity and ecosystem.
Biophilic design is a psychology which allows human to be close to nature and to be an integral part of the nature around , helping it to revive and grow.

Biophilia and Sustainability –
The concept of sustainability has been discussed widely on confronting various environmental crises like resource scarcity, climate change, fight against hunger protection of biodiversity and sick building syndrome and has emphasized on use of vernacular strategies and energy efficient mechanism in the design approach.
Biophilic design offers a number of strategies for supporting sustainable growth in Architecture. The 2030 agenda of sustainable development goal has emphasized on 17 SDG (UN, 2015) to setup a guided growth in sustainable manner.

Sustainable Development Goals		**Biophilic Interventions**
SDG-1	No Poverty	Provide affordable housing by use of reduced energy and green construction materials.
SDG-2	Zero Hunger	Food security for all by enabling Urban farming and encouraging food production at individual and community level.
SDG-3	Good Health and Wellbeing	Improve indoor air quality, optimize thermal comfort, daily encounter with nature through physical activities like running, jogging or cycling. and integrating biophilia to design process.
SDG-4	Quality Education	Integrating Nature based study with technology for all round development of children. So as to avoid nature deficit syndrome among children.
SDG-5	Gender Equality	Universal and Inclusiveness approach in design to address issues of gender inequality.
SDG-6	clean Water and Sanitation	Following procedures of Rain water harvesting, storm water management, water recycling and conserving runoff water.
SDG-7	Affordable and Green energy	• Enhance building passive cooling system, • Reduce dependence on non renewable source and increase dependence on solar, water and wind energy to achieve daily energy needs.
SDG-8	Decent work and Economic growth	Healthy and productive work environment by including nature and natural elements into workplace design.
SDG-9	Industrial Innovation and Infrastructure	• Strict building standard norms in terms of pollution, energy consumption, health

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		and safety. • Increase building rating system for sustainability.
SDG-10	Reduced inequality	• Inclusiveness for all social groups • Universal design approach • accessibility to public Infrastructures.
SDG-11	Sustainable cities and communities	Affordable, accessible, healthy cities with increased livability
SDG-12	Responsible consumption and production	• Use of Indigenous materials & native plants • Durability & resilience • Climatic comfort and minimum energy consumption
SDG-13	Climate Action	• Resilience to flood, rainfall, heat wave, draught & hurricane • Reduce urban heat island • Reduce noise, pollution and increase wind flow.
SDG-14	Life bellow Water	• Reduce water pollution (sea, lake & river) • Regeneration of polluted land close to sea
SDG-15	Life on Land	• Protect, restore and support ecosystem & biodiversity • enmark lands in urban areas for habitat of animals
SDG-16	Peace, Justice and strong Institution	• Safety, inclusiveness and affordability for public housing • Offer public housing and night shelters
SDG-17	Partnerships for the Goals	Collaboration with different stakeholders & professionals to achieve sustainable goals through biophillic design interventions.

SURVEY ANALYSIS –

A) Contribution of open space around build structure towards climate change resilience and wellbeing –
- Build coverage : open space ratio = 40:60 (for effective output)
- Hardscape : softscape ratio

B) Contribution of human controlled opening towards climate change resilience and wellbeing –
- Controls opening area as per outside climate condition
- Helps in reduced Energy consumption of mechanical ventilation and cooling system
- Access to outside nature to boost mood and relieve stress (visual connectivity to nature)
- Sensory contact with nature for wellbeing – smell of foliage, sound of birds, bees & water, sight of outdoor biodiversity and touch of texture (wood, stone, soil)

C) Contribution of Biodiversity towards climate change resilience and wellbeing
- Green Roof – thermal comfort, storm water management, proximity to nature and species
- Living walls – controls airflow, home for biodiversity, screens pollutants and improves air quality.
- Indoor plants – Live plants benefits - relieve stress, medicinal benefits, improves air quality,
- Artificial plant benefits - relieve stress, mental comfort, adds aesthetics to interior, maintenance free, durable and economic.
- Water bodies, aquariums and fountains – relieve stress, mental comfort,

D) Access to public space, parks, wild at regular interval (weekends)
- Regular public nature interaction generates a bond of social cohesion and sense of responsibility.
- Educating children about the benefits of green help improve learning capacity among children.
- Regular encounter with nature through physical activities reduce blood pressure, and relieve from insomnia and appetite disorder.

OBSERVATION & FINDINGS –

9 commercial office spaces in Bhubaneswar are chosen and the impact of various biophilic elements on their micro climate are tabulated bellow

Implementation of Biophillic patterns in Commercial Office spaces

Biophillic Design Elements and Patterns / Commercial Office Complexes	1- Visual Connection with Nature	2 - Non-Visual Connection with Nature	3 - Non-Rhythmic Sensory Stimuli	4 - Thermal & Airflow Variability	5 - Presence of Water	6 - Dynamic & Diffuse Light	7 - Connection with Natural Systems	8 - Biomorphic Forms & Patterns	9 - Material connection with Nature	10 - Complexity & Order	11 - Prospect	12 - Refuge	13 - Mystery	14 - Risk	Biophillic Score	% Biophillic (Green Rating	Photos
1. Krushi Bhawan	●	●	●	●	●	●	●	●	●	●	●	●			12	85	
2. Kharavella Bhawan	●	●	●	●		●				●		●			7	50	
3. Police Commissionerate Building	●	●	●	●	●	●	●			●					8	57	
4. Bhubaneswar Development Authority	●	●	●	●		●			●						6	42	
5. Deloitte Building and IMC	●	●	●	●		●	●		●	●	●				9	64	
6. Shakti Bhawan (Accenture & Cognizant)	●	●	●	●	●	●	●	●	●	●	●	●	●		13	92	
7. Unnati Bhawan	●	●	●	●	●	●	●		●	●	●				10	71	
8. IDCO & IPICOL Tower	●	●	●			●			●						5	36	
9. OPTCL Tech Tower	●		●			●			●						4	29	

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Observations and Findings are listed bellow

1- Biophilic Design and Climate change –
- passive solar design to ensure indoor comfort.
- External living walls to reduce pollution, noise and urban temperature, habitat for plants and other biodiversity,
- presence of greenery to lessen the perceived temperature.
- appropriate facade and floor plan design to meet daytime lighting needs for visual comfort while reducing building electrical and cooling costs.
- Operable windows to provide natural ventilation and comfort while reducing the need for mechanical air circulation.

2- Biophilic Design and Human comfort and wellbeing –
- biophilic design interventions can regulate urban microclimates through the provision of shade and windbreaks.
- Direct contact with vegetation in and around build environment to enable comfort.
- The presence of plants in build envelope to reduce stress, improve comfort, enhance mood, and prompt healing.
- Incorporation of Rain water harvesting and water management system to support infiltration of storm water .
- Sensory experience of stability and refuge.
- Natural settings like landscaped campuses, green rooftops, vertical landscape to foster psychological stability and anchor resilience and encourage social cohesion.
- Incorporation of natural materials (wood, stone, water, etc.) to build spaces are healthier for occupants and help reduce stress and foster wellbeing.
- views of nature, plants, animals, and outdoor sceneries have positive psychological impact on occupants health and wellbeing.

3- Employee Well-being Metrics
Findings indicate significant improvements in employee well-being in a Biophilic Build environmental surrounding:
- Stress Reduction: 37% decrease in reported stress levels
- Job Satisfaction: 42% increase in workplace satisfaction
- Physical Health: 28% reduction in reported headaches and eye strain
- Productivity: 15% increase in task completion rates
- Attendance: 12% reduction in sick leave usage

4- Biophilic Design and bio-diversity Conservation-
- Integration of nature to buildings can contribute to biodiversity conservation.
- Incorporating green roofs, living walls and habitat corridor has helped in creation of urban ecosystem.
- Bio-diversity conservation has helped provide shelter to various animal species.
- Help enhance biodiversity and enhances ecosystem services such as pollination and storm water management.
- Parks, pathways and water bodies provide critical habitat for a wide range of urban or peri-urban species.
- Biophilic buildings facade help provide habitat for a number of micro biodiversity, support valuable micro climates and enhance quality of life for occupants.
- The health and productivity of our urban gardens depends largely on the biodiversity communities, particularly insects and butterflies.

CONCLUSION –

Stress is something that is unavoidable in a corporate work environment. corporate office employees spend almost 90% of their work time indoor, infront of computers. This results in insufficient contact with nature, natural view, light, materials, shapes, and forms which are critical to our wellbeing. The impact of Stress on our brain can influence memory and result in lack in concentration, memory loss, insomnia and even cognitive disorder,. Health and well-being are essential for all human to lead a peaceful life. The quality of work environment determines the quality of life and amount of work productivity. Biophilic approach to work environment can result in mitigating climate change related issues and can help reduce stress and boost productivity, efficiency and creativity. Biophilic design also help reduce the ambiance temperature and help to reduced load on energy consumption thereby enhancing sustainability.

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