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"Every effort needs to be looked at in a larger perspective and the impact it is going to make"

Dear Readers,

Greetings from the Editorial Team.

With this issue we present to you the August 2025 issue of the "Subharti Journal of Interdisciplinary Research". On behalf of the editorial team let me begin by thanking one and all who have contributed directly or indirectly to make this issue see the light of the day. We have received submissions from almost all faculties and we are focussing on publishing the research articles which are worthy of making an impact in the long run, so a priority has been given to quality over quantity. We are having a good submission rate and are trying to maintain a healthy acceptance rate. We have tried to accommodate everyone but due to few constraints, some articles will be published in the upcoming issues.

Our next target is to increase the visibility of the journal and for that we are trying to get the indexing bodies to recognize the efforts put in by the editorial team. For getting the journal indexed we need to have submissions from outside the university and we would like to request everyone to give wide publicity to the journal and share it far and wide on various social media platforms so that we can get submissions from local to global.

Another target that we have set for ourselves is to digitalize the submission and article processing process. We would soon be starting groundwork regarding the same and hope that the next issue will see a much more user-friendly interface.

Coming back to the journal, I seek your support and look forward to welcoming your submissions for next issue and your valuable suggestions are eagerly awaited.

Stay Happy, Stay Healthy

Happy Reading

Dr Vijay Wadhwan

Editor-in-Chief

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Short Communication

Social and Psychological Consequences of Performative Masculinity in *Dance Like a Man*

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Abstract

Bharatnatyam, in its traditional sense, is considered as a women art form. *Dance Like a Man* by Mahesh Dattaniis a complex interplay of the psychological and social impacts of performative masculinity on Jairaj, a male protagonist whose passion for Bharatanatyam, a classical Dance in India, clashes with societal expectations of masculinity. This study incorporates a mixed method approach of qualitative and quantitative analysis that the intergenerational consequences of these pressures of masculinity is not only performed but also policed within familial and cultural frameworks.

Keywords: Masculinity, Feminine Art, gender, Social and Psychological effects

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Background Information

In India masculinity is frequently connected to social standing, power, and control. One of India's most well-known modern dramas, *Dance Like a Man*, reconnoiters the challenges faced by Jairaj, an artist who wants to pursue a career in Bharatanatyam dancing(1). His father, Amritlal, blocks his path of making career in Bharatnatyam by forcing patriarchal ideas of masculinity, which causes him to become socially isolated and suffer from psychological anguish.

According to Butler (1990)(2) and Connell (2005)(3), masculinity is a social performance shaped by institutional power structures and cultural norms rather than an innate quality. This performativity is demonstrated in *Dance Like a Man* by Jairaj's attempt to balance his love of dance with his father's strict ideas of what it is to be a man. Amritlal, a patriarch and former freedom fighter, tries to make Jairaj into a "respectable" man who represents traditional masculinity through economic stability, power, and control over women(4). Jairaj suffers from extreme psychological anguish due to his father's imposed expectations which leads to broken relationships, a deep sense of inadequacy, self-doubt, and emotional suppression.

Aim and Scope

This article aims to examine the construction of masculinity through the lens of performative gender theory by integrating textual analysis with empirical data from a small-scale survey. The study explores how societal perceptions and cultural narratives shape and reinforce internalized notions of masculinity(6). The scope of the research encompasses both literary and sociological dimensions, focusing on how traditional gender roles are perpetuated and challenged within specific cultural contexts(7). By combining theoretical insights with field data, the article seeks to offer a nuanced understanding of masculinity as a dynamic and socially constructed identity.

Result and Discussion:

The qualitative analysis determines that Mahesh Dattani's *Dance Like A Man* is a compelling exploration of performative masculinity. It functions as both a personal burden and a socio-psychological construct that commands the course of individual lives. The article highlights that masculinity is not an inherent or stable identity, but a performance—enforced by societal expectations, cultural norms, and patriarchal ideologies(5). Jairaj's desire to pursue Bharatanatyam, a classical dance form often gendered as feminine, positions him in direct conflict with the rigid masculine ideals upheld by his father,

Amritlal[8]. This conflict builds a larger narrative of emotional repression, failed communication, and intergenerational trauma.

The small scale survey deals with the data analysis of 19 respondents out of 20, both male and female, who were between the ages of 20 and 22. A structured questionnaire comprising eight questions (seven close ended and one open ended) about performative masculinity and its psychological and social ramifications was utilized to collect the data. One of the key questions asked in the survey was:*"What comes to your mind when you hear the phrase 'Beaman' or 'Actlikeaman'?"* This question aimed to explore common societal perceptions and internalized meanings attached to masculinity.

The survey findings reveal that a significant majority (80%) of respondents recognize the societal pressure imposed on men to adhere to conventional masculine norms. Despite growing awareness, male participation in artistic fields—particularly in classical dance—continues to be shadowed by persistent stereotypes. These ingrained perceptions not only discourage men from pursuing careers in the performing arts but also reinforce restrictive gender roles that negatively impact their psychological well-being. Respondents widely acknowledged that such rigidity contributes to emotional suppression and mental distress among men. Notably, 80% of participants rated the freedom to choose a career free from gender-based expectations as "very important," underscoring a strong desire for more inclusive and equitable opportunities. However, only 20% believed that men are able to express emotions openly in

Furthermore, an overwhelming 80% contemporary society, highlighting the enduring long- play a vital role in dismantling stigma surrounding held biases and challenging traditional stereotypes agreed that fostering gender equality in the arts can male vulnerability

The **bar chart** represents the thematic analysis of responses to the phrase **"Be a man"** based on survey. It visually highlights the frequency (in percentage) with which each theme appeared among the 19 respondents.

The analysis of participant responses revealed that the most commonly identified theme was **emotional suppression** (63.2%), with a majority linking masculinity to the expectation of hiding emotions, remaining stoic, and avoiding vulnerability. **Traditional masculine traits** such as strength, courage, independence, and responsibility were noted by 47.4% of participants, indicating that these ideals continue to dominate perceptions of manhood. Approximately 42.1% of respondents reflected an awareness of **social conditioning and stereotyping**, emphasizing how rigid gender norms shape male behavior from an early age

A critical stance was taken by 31.6% of participants, who argued that phrases enforcing traditional masculinity are outdated and may contribute to mental strain and aggression among young men. On a more progressive note, 26.3% of respondents expressed support for a positive reinterpretation of masculinity, advocating for emotional openness, empathy, and ethical strength. Lastly, a small minority (10.5%) expressed **confusion or** indifference, suggesting limited engagement with or awareness of contemporary gender discourses.

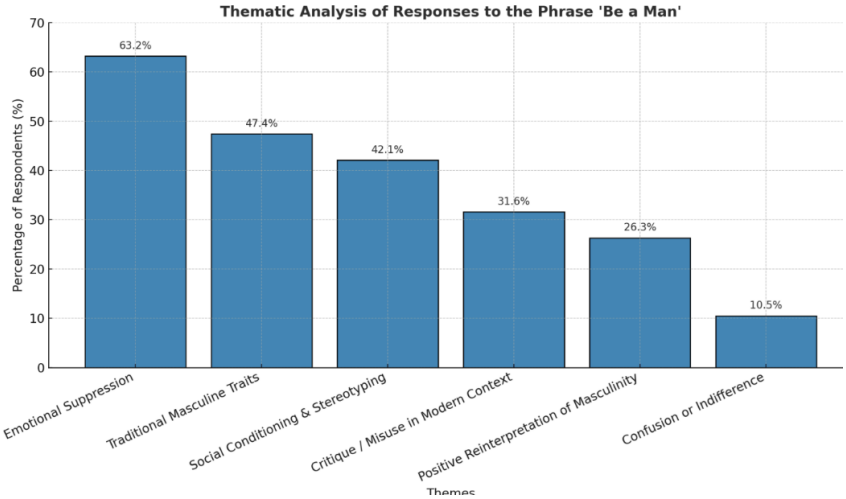

Figure 1: Thematic Frequency of Respondent Views on Performative Masculinity

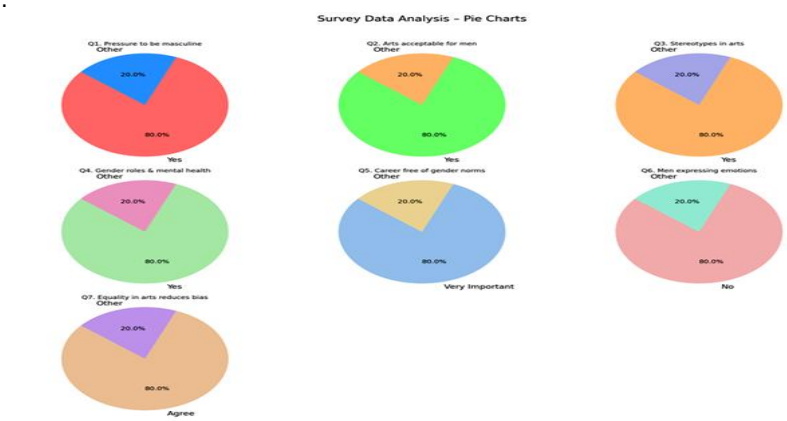

Figure 2: Visual Representation of responses through Pie Charts.

Conclusion

Mahesh Dattani's *Dance Like a Man* poignantly reveals that masculinity is not merely a social expectation imposed from the outside but a deeply internalized performance—one that governs behaviour, suppresses emotional expression, and often leads to psychological conflict. Through Jairaj's struggle against the rigid masculine ideals embodied by his father, Dattani critiques the emotional toll of traditional gender norms and invites readers to reflect on the hidden costs of conforming to these expectations. The play becomes a compelling cultural and literary interrogation of masculinity, advocating for more inclusive, empathetic, and fluid understandings of gender identity.

The survey results strongly echo the concerns raised in the play. A significant majority of respondents associated masculinity with emotional suppression, rigid stereotypes, and mental health challenges. Many acknowledged the societal pressure on men to conform to predefined roles and highlighted the importance of freedom in career and emotional expression. The findings also revealed growing support for a reimagining of masculinity—one that embraces vulnerability, empathy, and individuality.

The literary analysis and empirical data underscore the need to dismantle performative gender roles and promote healthier, more authentic expressions of masculinity. This study calls for continued critical engagement with cultural narratives and social structures that reinforce limiting gender norms and urges a shift toward more open, compassionate, and psychologically sustainable models of manhood.

Source of Support: Nil

Conflict of interest: Nil

Acknowledgement: None

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Original Article

Stigma and Children with Disability withSpecial Reference to Kokrajhar District, Assam

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Abstract:
This article has stated about the stigma of children with disability. When children with disability are commented as falls, the assumption is known as stigma, for the study of stigma reviews of literature are studied. One objective is considered and under this objective four questions are selected. The objective is to examine the opinion of the stigma of teachers and the significant role of teachers, towards children with disabilities. The data are collected in the Google form and interview techniques are taken from different Headmasters of High Schools, Higher Secondary Schools, and students with disabilities. The descriptive survey method is selected for the study besides the focused group interview. The data were collected randomly from 45 teachers from the schools in the Kokrajhar District. The study is based on a qualitative method. The analysis is done with discussion and the conclusion is given after the suggestion.

Keywords: Stigma, Children and Disability

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1. Introduction

Disability is not an unknown problem. Disability is which affects daily activities in some particular areas like self-direction, self-care, capacity for independent living, learning, economic self-sufficiency, mobility, expressive language capacity to receive information. Most of the problem for children with disability is participation in all activities which leads to stigma. In the world, 15% of people are suffering from disabilities and 110-190 million people in the world have difficulties in daily function [(1).]

Children are an important asset to the nation. "According to 1974, The National Policy for Children stated that Children are the supreme assets of the nation whose nurture and solicitude are the responsibility of the nation". All individuals are unique in their physical structure, mental ability, observable behavior, learning ability, etc. Learning disability is one kind of disorder that affects a person's ability to see, listen, speak, write, read, and do mathematical calculations resulting from cerebral dysfunction or behavioral disturbances. There are different types of physical disabilities. They are visual impairment, deaf and blind, hearing impairment, health impairment, motor problems, and hyperactivity, memory disorder, Traumatic brain injury, Autism, speech and language impairment, etc[(2)]. These problems develop the attitude leading the stigma among the common people.

2. Stigma:

Stigma is when people with disability are commented as falls assumptions are known as stigma. There are some assumptions and beliefs that children with disability are not able to learn. Stigma is the negative attitude, prejudice, or belief held by society or individuals towards someone. In modern society the concept of stigma has evolved and, it can be applied to different individuals or groups based on culture, gender, socioeconomic status, race, health status, and religion. When one person is stigmatized or commented develops psychological problems, and discrimination, in society. This type of stigmatization affects the own self- perception which leads to psychological problems. Stigmatized people sometimes can perceive and be aware that they are treated differently which begins from an early age and affects their own identity, and perception that are around them. It changes the behavior of the person that makes shapes, beliefs and emotions[(3)]

According to Merriam Webstar, stigma is the set of unfair beliefs or negative attitude. It is a bodily mark and paints that resembles wounds of the crucified Jesus and is accompanying religious custody. It is one kind of Negative attitude, false believes and prejudice associated with some specific traits.

3. Major concepts:

i. It is a unfair believes that sets of negativity where the groups and society have something about the children [(4)].

ii. When a child is named or labeled illness they are observed as part of a stereotyped group. The negative attitude leads to negative actions and creates prejudice in society [(5)].

iii. It is the characteristics of one person or one group that has defects and is humiliated or isolated who is thought to have this characteristic [(6)]

It can be divided in to two categories:

Persons with disabilities (PWDs): It involves those who have strong mental, intellectual, and long-term impairments and have different barriers to participation in society and comparison to others.

Students with disabilities: A student who has faced learning difficulties and is not able to achieve minimum requirements in comparison to a normal child. They need special education Services and the development of individual plans or National Education plans

4. Why is stigmatization arising?

Stigmatizations arise by following way-

i. A disabled child is ugly.

ii. A child who has a disability cannot learn and study

iii. Cultural and social norms: Disability is in some societies marked as a curse, punishment, and shame. They are the product of their parent's and ancestors' sins and as a result of punishment they get that product

iv. Fear and understanding of Children with a disability, chronic illnesses, special needs, misconceptions, and lack of knowledge have led to the stigma

v. Families of children with disabilities who have low socio-economic status related to poverty have been facing stigma.

vi. Children with disabilities have been facing stigma due to diverse ethnic cultural backgrounds and stereotypes.

vii. Children who have traumatic experiences may experience stigma for the lack of fear and understanding

viii. Children who have been facing academic problems can be labeled as Lazy or 'not smart".

viii. The long-term historical treatments of disabilities such as segregation, and institutionalization have contributed to developing the stigma [(7)].

5. Effects of stigma:

The effects are given in the following:

i. **Low self-esteem**: Stereotypes and Negative attitudes may develop into low self-worth and low self-esteem in children with disabilities

ii. **Social isolation**: Children with disabilities develop social exclusion from some social activities which leads to loneliness

iii. Mental health concerns: This type of children leads to experiences depression, anxiety, and health concerns of the stigma

iv. Limited opportunities: Stigma leads to limited education, health care, and employment opportunities for children.

6. Significance of the study:

Stigma is an unspoken attitude that prevails in society related to the disability of children. There are some problems which are not created by him or she or it is not in the hands of his creation. It is believed in the creation of God. But man's mind cannot be controlled and develops some attitude which is complex and miss assumed. But in modern times more problems can be cured with the help of medication.

7. Study area:

Kokrajhar district is situated at the west part of Assam. There are five blocks in the Kokrajhar District- Kachugaon, Kokrajhar, Gossaigaon, Dotma and Parbatjhara. The data are collected from each block randomly.

8. Objective Of the study:

To study the opinion of the stigma of teachers and the significant role of teachers towards children with disabilities

9. Methodology of the study:

Research methodology is a logical and systematic process where the investigator uses a specific topic for achieving and gathering information.

Research methodology is divided into two types. One is qualitative and the other is quantitative research. In the present study qualitative research method is used.

9. i Qualitative method of study: In qualitative research in-depth study and interview is very important with two persons and more than two persons besides the focus group. Qualitative research is inevitable when the researchers want to know the specific opinions, and behaviors, on certain experiences and subjects related to values, beliefs attitudes, and cultures. Qualitative methods of research have been used in health sciences, social sciences, anthropology, and psychology.

9. ii. Sample of the study: The sample of the study is one of the subsets of populations or several objects considered for the investigation. The term sample is applied to the collection of data and drawing. In the present study, 45 head teachers are selected from the Kokrajhar district. The data are collected from each block randomly. The researcher has gone to the schools, taken interviews with the children with disabilities, observed them, and asked about their difficulties. Information is taken by Google form also

9. iii. Sources of data: Out of two sources, i.e. primary sources and secondary sources, data are collected. Primary data is taken from interviews, questionnaires, and observation and secondary data are collected from the census report, Sodhganga, journal of different articles.

10. Analysis and interpretation of the study:

Data analysis is the systematic process of elaboration of extracting insight from data. In the present study, qualitative analyses are done based on images, text, and observations. By using qualitative data the researchers have been using a deep insight or understanding about the special complex phenomena and outcomes related to stigma.

Analysis is done according to the objectives

ObjectiveNo-1

To study the opinion of teachers about the stigma (negative perception) of children with disabilities and related significant role

11. Discussion of the study:

In most countries, people are facing different problems like stigma due to not having good health and lack of socioeconomic conditions of the people mentioned in the paper [(8)] mentioned that Children with disabilities face problems due to proper diagnosis, treatment, and parent's communication with teachers and doctors [(9)]

Mentioned in the Indian Journal of Psychiatry about the stigma of mental illness which is done research work in semi-urban and rural communities and it was revealed that significant changes are seen in the second intervention attitude [10] Every child has to face the attitude of stigma but is different from person to person. Due to lack of information parents do not check up the health of children and consult with doctors about the children's problems.

conditions are not good. Due to this problem, they are not able to receive the information

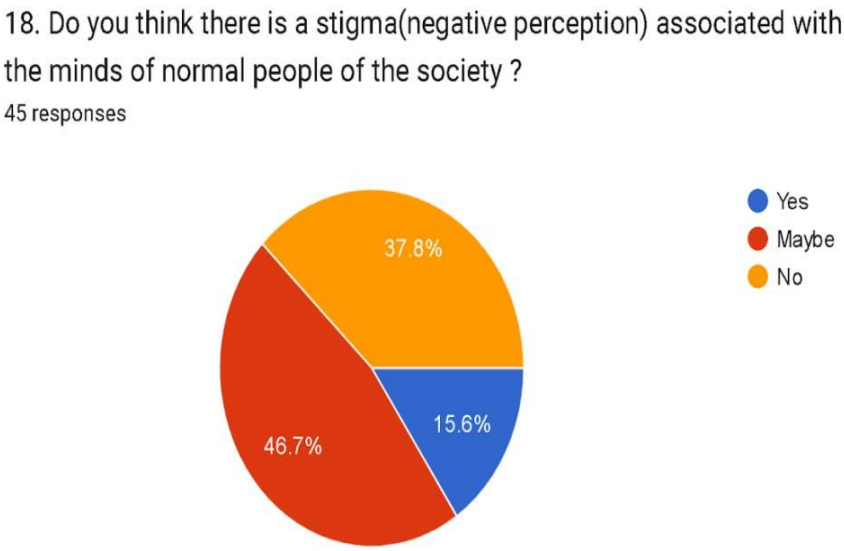

Figure No. 1 a

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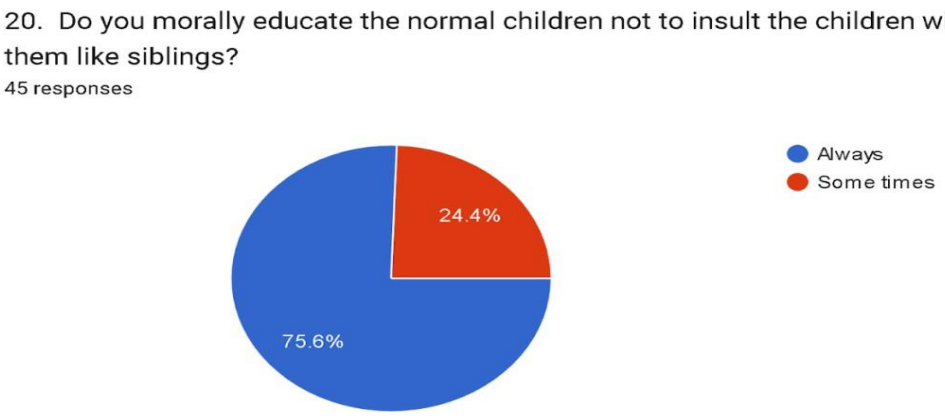
Some parents are illiterate and socioeconomic

From the above Figure no. 1 it is revealed that teachers responses in respect of stigma (negative perception) that associated with children with the disabilities are found 15.6%,' no' responses have been found 37.8% and 'may be 'responses 46.7 %. In the society still the attitude of sigma are not removed totally.

1. b. significant role of teachers in teaching normal children about themorale education towards the children with disabilities

Figure No.1.b



From the figure no. 1.bIt is revealed that responses of teachers in respect of morally educating normal children not to be insulting the children with disabilities and treating them as their siblings are found 75% in respect of 'always' and 24% is found in respect of 'some times'

12. Suggestions for the eradication of stigma:
The following ways are necessary for the eradication of stigma

i. Education and awareness: To eradicate of stigma of children with disability awareness is necessary for educating the public.

ii. Representation of Positive media: Media can help in reducing stigma of the children with disability in respect of challenging stereotypes feelings.

iii. Supporting families: It can be helped by providing resources, social inclusion, and support to the families for eradication of Stigma.

iv. Focus on abilities: Promoting strengths and abilities of children with disabilities despite their limitations.

v. Educate others: In educating the children some resources and information should be shared among the community members, friends and family members.

vi. Advocate for inclusion: Promoting social inclusion, advocating a good inclusive environment and accessibilities. An inclusive environment is essential for the eradication of stigma by promoting accessibility with a good environment.

vii. Occupational therapists and Doctors time to time visit is very important.

viii. Atraditionalmethodofyogaandphysicalexerciseareessentialforreducingsome problems of disability.

ix. Physiological therapy is more in evitable for the children with disability

13. Conclusion:

There are some misconceptions in society including brain injury, mental retardation, and cerebral palsy. The greatest strange of limitations is that these are not earned by themselves but antiquated attitudes that lead to rejection in the society. But at present situation due to the result of modern science, more children with disability can be helped with sufficient medication and eliminate different disorders in association with an understanding of teachers and classmates.

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Conflict of interest: Nil
Acknowledgement: None

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Review Article

Strength Beyond Limits: The Role of Sports in Uplifting Disabled Women in Contemporary India

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Abstract—
Disabled women face unique challenges and barriers in society, often experiencing intersectional discrimination due to their gender and disability. Sports can play a transformative role in empowering these women by promoting inclusivity, enhancing physical and mental well-being, and fostering social integration.In the context of India, this paper delves into the initiatives, policies, and programs implemented to facilitate the empowerment of disabled women through sports. It analyzes the impact of these efforts on promoting gender equality, challenging stereotypes, and providing equal opportunities for disabled women to participate and excel in various sports disciplines. This paper examines the empowerment of disabled women through sports and evaluates India's progress in this contemporary scenario. Additionally, it investigates the existing infrastructure, facilities, and accessibility measures available for disabled women in sports across different regions of India. It examines the role of governmental organizations, non-profit entities, and grassroots initiatives in creating an enabling environment for disabled women's active engagement in sports. Furthermore, it also explores the social and cultural implications of disabled women's participation in sports in India. It examines the changing perceptions, societal attitudes, and the breaking down of stigmas surrounding disability and women's capabilities in the sporting arena.

Keywords: Women empowerment , Disability, Sports, Inclusivity

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Introduction

"Sports serve society by providing vivid examples of excellence." —George F. Will

Women empowerment is a crucial movement that has gained significant momentum in recent years. It encompasses the collective efforts to provide women with equal opportunities, rights, and resources to thrive in every aspect of life. Through empowerment, women are breaking barriers, shattering glass ceilings, and rewriting the narrative of their own potential. It involves promoting gender equality, challenging societal norms, and eliminating discriminatory practices that hinder women's progress. Women empowerment recognizes the inherent value and abilities of women, empowering them to make choices, pursue education and career goals, and participate actively in decision-making processes. By empowering women, societies unleash a powerful force for positive change, as women's successes radiate to benefit families, communities, and entire nations. This ongoing movement is a testament to the remarkable resilience, strength, and potential of women, as they continue to inspire and transform the world around them.

The empowerment of disabled women holds immense significance in fostering a truly inclusive and equitable society. Disabled women face multiple layers of marginalization due to their gender and disability, often leading to exclusion, limited opportunities, and societal barriers. Recognizing the importance of empowering disabled women is essential not only for their individual well-being but also for promoting social progress and realizing the principles of equality and human rights.

Empowering disabled women goes beyond addressing their specific needs and challenges; it involves creating an environment that respects their rights, recognizes their unique talents, and provides equal opportunities for their full participation in all aspects of life. By empowering disabled women, society can tap into their immense potential, promote their autonomy, and enable them to contribute meaningfully to various spheres such as education, employment, leadership, and cultural expression.

One crucial avenue for empowering disabled women is through sports and physical activities. Sports not only enhance physical fitness and overall well-being but also play a transformative role in promoting self-confidence, building resilience, and fostering social integration. Through sports, disabled women can challenge societal stereotypes, break down barriers, and redefine societal perceptions of disability.

Furthermore, empowering disabled women is a matter of social justice and human rights. It entails dismantling discriminatory practices, ensuring access to quality healthcare, education,

employment, and promoting inclusive policies and laws. By empowering disabled women, society can advance towards a more inclusive, diverse, and compassionate future, where every individual's rights and capabilities are recognized and celebrated.[3]

In this regard, this paper aims to explore the importance of empowering disabled women, highlighting the transformative impact it can have on individuals, communities, and society as a whole. It will delve into the various dimensions of empowerment, including access to education, healthcare, employment, and social participation. Additionally, it will examine the role of sports and physical activities in empowering disabled women and fostering their holistic development. By understanding and prioritizing the empowerment of disabled women, we can strive for a society that values and upholds the rights and dignity of every individual, regardless of their abilities or disabilities.

Literature Review

1. Elisabet Apelmo *Sport and the Female Disabled Body* (2018)

In this book, the author discusses the paradox of gender. Disabled bodies are often seen as non- gendered, however, these young women's experiences are structured by both the gender regimes within sports and the larger gender order of the society.

2. Women, disability, and identity (Asha Hans & Annie Patri eds., 1 st ed. 2003)
This volume consists of critical and theoretical articles about women with disabilities in both developed and developing countries. Disabled women and their place in these societies has been a subject that has been neglected in the past, therefore these essays will fill a gap in the evolving literature on disability studies. This volume, therefore, attempts to provide a space to women with disabilities in the global feminist literature and movement.

3. Dr. Balaji P. Jadhav *Women Empowerment Through Sports and Physical Education* (2015)
In this book author highlights that in coming years the prejudice faced by sports women will decline. The initial chapters reflects that the gaps between the male and female achievements in sports is reducing

4. James I. Charlton *Nothing About Us Without Us: Disability Oppression and Empowerment* (2000)
A theoretical overview of disability oppression that shows its similarities to, and differences from, racism, sexism and colonialism. The analysis is supplemented by interviews conducted over a ten-year period with disability-rights activists throughout the Third World, Europe and the USA.

5. Joseph P. Shapiro *No Pity: People with Disabilities Forging a New Civil Rights Movement* (1994)
In this book author highlighted that disabled are not matter of pity. In order to gain common respect, disabled people should continue their struggle to break all the prejudices Disable should strive to attain equality until achieved.

6. Disability, Gender, and the Trajectories of Power (Asha Hans ed., 2015)
This book draws attention to the suppression of disabled women and seeks for "a non discriminatory" approach that can safeguard the needs of disabled women as well as give them equal human rights within feminist movements . Giving a purview of the injustice and discrimination against disabled women across the globe and pointing some specific discriminatory actions followed in India that target disabled women.

7. Prem Kumar Agarwal and Shashi Nath Mandal *Empowerment of Women: Human Rights Perspectives* (2017)
This book is compilation of papers touching different realms relating to human rights and women. It is an insightful and thought-provoking book that delves into the multifaceted issue of women's empowerment through the lens of human rights.

8. Mrs. Indumathi Rao *Equity to women with disability in India - A strategy paper prepared for the National Commission for Women* (2004)
This strategic paper delves into the circumstances faced by women with disabilities across India. The study examines the pervasive discrimination endured by these women, encompassing various aspects of their lives such as education, training, employment, and healthcare

Research Methodology

The research paper on "Strength Beyond Limits: The Role of Sports in Uplifting Disabled Women in Contemporary India" adopts a doctrinal research methodology to examine the legal framework and relevant legal sources pertaining to disabled women's empowerment in sports in India. The following research methodology is employed like identification of legal sources including statutes, regulations, policies, case law, and international legal instruments relevant to disability rights, women's rights, and sports in India. This analysis also involves examining key statutes, court decisions, government policies, and legal precedents to understand the legal rights, obligations, and barriers faced by disabled women in sports. In addition to analyzing domestic legal sources, the researcher may conduct a comparative analysis

3. Dr. Vaibhav Goel Bhartiya, Rights of Disabled Persons: An Analysis of Indian Legal Framework. Jan Sanchar Vimersh: A Bi-Lingual Media Research Journal 134-137 (2017).

of international legal instruments and regional frameworks.

Disabled Women and Sports: Human Rights Perspective

The right of access to and participation in sport and play has been recognized in a number of international instruments, including Article 24 & 27 of the Universal Declaration of Human Rights , Article 15 of the International Covenant on Social, Economic and Cultural Rights , Article 31 of the Convention on the Rights of the Child , Articles 10 and 13 of the Convention on the Elimination of all Forms of Discrimination against Women and Article 30 of the Convention on the Rights of People with Disabilities. Under article 5 of the Committee on the Elimination of all Forms of Discrimination against Women, States have to put all necessary measures with a view to achieving the elimination of all practices which are based on the idea of gendered stereotypes, including in the area of sport.

There is another side of the coin, which reflects that using sport to promote human rights for all and to strengthen universal respect for them. Sports may work as an avenue for the harmonious development of humankind, with more peaceful society duly considering the inherent dignity and personhood. Utilizing sports as a platform, we can empower disabled women, raise awareness about their rights, and work towards creating an inclusive society that respects and upholds their human rights. Navi Pillay, UN Human Rights chief at a panel discussion on sport and human rights conducted by UN Human Rights Council said that human rights and sports exhibit numerous objectives and fundamental values in common. The lack of interaction between the human rights movement, mechanisms, institutions, and the world of sport is astonishing said.[4] This matter explores *the transformative potential of sports in strengthening respect for human rights specifically for disabled women*.

Breaking Barriers and Challenging Stereotypes:

Sports can challenge societal stereotypes and misconceptions surrounding disability, particularly in the context of women. Disabled women participating in sports can defy preconceived notions of limitations and inspire others by showcasing their strength, determination, and athletic prowess. By challenging these stereotypes, sports can play a pivotal role in fostering respect for disabled women's rights, promoting inclusivity, and encouraging a shift in attitudes towards disability. It will divert world attention from disability towards their abilities

Positive impact on Physical Rehabilitation Programme

It has been observed that when sport was integrated into physical rehabilitation programme it has shown progressive results. Integrating sports into physical rehabilitation programs can significantly enhance motivation and adherence to the rehabilitation process. It has also been shown to have psychological and social benefits for individuals with disabilities particularly women. By leveraging the power of sports, these programs have enhanced physical rehabilitation, increased motivation, developed essential skills, fostered community integration, and empowered individuals with disabilities. In Cambodia, Afghanistan, India, Ethiopia, Gaza, and Bangladesh, the ICRC actively supports sports related physical rehabilitation activities. Additionally, partnerships have been established with paralympic committees to implement projects in Niger and Iraq.[5]

Promoting Physical and Emotional Well-being:

Participation in sports can have a profound impact on the physical and emotional well-being of disabled women. Regular engagement in physical activities not only promotes physical fitness but also contributes to improved mental health, self-esteem, and body image. By providing opportunities for disabled women to engage in sports, we can enhance their overall well-being, empowering them to lead fulfilling lives and assert their rights to health and well-being.

Access to Equal Opportunities:

Disabled women often face significant barriers to accessing opportunities in various spheres of life. Sports can serve as a catalyst for change by providing a level playing field where disabled women can showcase their abilities and talents. Ensuring equal access to sports facilities, training, and competitions for disabled women helps promote their right to participate in recreational activities, develop their skills, and pursue sporting careers. By creating an inclusive sports environment, we can address the systemic discrimination that often limits disabled women's opportunities.

Empowerment and Leadership Development:

Sports can serve as a vehicle for empowerment and leadership development among disabled women. Engaging in sports fosters self-confidence, resilience, and teamwork, empowering disabled women to assert their rights and challenge the barriers they face. Sports-based programs that

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[4] Harnessing the potential of sports for human rights, UN Human Rights (2012) https://www.ohchr.org/en/stories/2012/02/harnessing-potential-sports-human-rights (last visited on Dec 15, 2024)

[5] https://www.icrc.org/en/document/sport-helping-rehabilitate-victims-war-and-armed-violence (last visited on Dec 15, 2024)

incorporate mentorship, coaching, and leadership training can further enhance disabled women's self-advocacy skills and equip them with the tools to become leaders in their communities and advocates for disability rights.

Visibility and Advocacy:

Sports provide a powerful platform for disabled women to raise awareness about their rights and advocate for inclusive policies and practices. By showcasing their achievements and sharing their stories, disabled women athletes can challenge the invisibility and marginalization they often experience. Their visibility in the sporting arena can inspire others, change perceptions, and mobilize support for disability rights. Disabled women athletes can become role models, breaking down barriers and serving as ambassadors for human rights, promoting respect and inclusivity for all.

Barriers

There are many barriers that disabled women comes across who wish to access sport and recreation-

1. Discrimination - The participation of women and girls in sport challenges a multitude of gender stereotypes and discrimination. For women with disabilities, this discrimination is far greater.
2. Lack of Role Models and Representation: Limited visibility of successful disabled women athletes and a lack of role models in mainstream media and sports coverage can contribute to a lack of inspiration and motivation for disabled women to pursue sports. The absence of representation can make it challenging for them to envision themselves succeeding in the field.
3. Limited grassroots opportunities - At the grassroots level, disabled individuals encounter challenges in accessing suitable training programs, facilities, and resources tailored to their specific needs. The lack of inclusive initiatives and dedicated grassroots structures hinders their ability to explore and engage in sports from an early stage.
4. Less media coverage - According to the World Health Organization, the insufficient media coverage of disability is often tied to prejudiced attitudes, negative perceptions, and stereotypes, which pose significant hindrances to achieving complete inclusivity and ensuring accessibility for individuals with disabilities to key social experiences.[6] This includes enhancing the presence and prominence of women sport reporters and analysts during significant events, as well as addressing and challenging instances of sexist depictions and unfair expectations regarding the conduct and attire of women athletes. Furthermore, it is important to encourage male athletes to actively join forces in promoting a culture that upholds values of equality, respect for diversity, and non-violence both within and beyond the realm of sports. Their participation in fostering such an environment will serve as a powerful model for others, ultimately contributing to a more inclusive and equitable society
5. Massive gaps in prize money and sponsorship - Across workplaces globally, for work of equal value women just earn approximately 77% of men's salaries. Similarly, within the realm of sports, there are substantial disparities in sponsorships, prize money, equipment, and facilities provided to female athletes. Sport federations and authorities have a crucial role to play in reversing this trend.[7]
6. Lack of accessible design - This becomes apparent in terms of accessibility and design, both in terms of physical structures and sporting equipment. What is missing is that features in products, facilities, and services being usable independently by individuals with a diverse variety of disabilities.[8]

Efforts Of International Paralympic Committee

Constitution of International Paralympic Committee (hereinafter as IPC) clearly states in its vision to make inclusion world through para sports and lays an identified objective of promoting social inclusion through para sports. The IPC functions as an umbrella organization, representing several sports and disabilities. IPC in its strategic plan (2019-2022) indicates enhancement of the paralympic games experience and advances its reach as a celebration of diversity among human race. Create opportunities for para athletes with different types of impairment, in particular athletes with high support needs, to compete in events with equal opportunities for male and female athletes. Advance the implementation of the Sustainable Development Goals & Convention on the Rights of Persons with Disabilities. .[9] The new strategic plan is also The new strategic plan is also released in march this year which states drive impact through para sports.

6 Olga Kolotouchkina & Carmen Llorente-Barroso & María Luisa García-Guardia & Juan Pavón, 2020. "Disability, Sport, and Television: Media Visibility and Representation of Paralympic Games in News Programs," Sustainability, vol. 13(1), pages 1-13, December

7 Phumzile Mlambo-Ngcuka, Op-ed: Empowering women through sport (2019) https://www.unwomen.org/en/news/stories/2019/4/op-ed-ed-phumzile-empowering-women-through-sport (last visited on Dec 16, 2024)

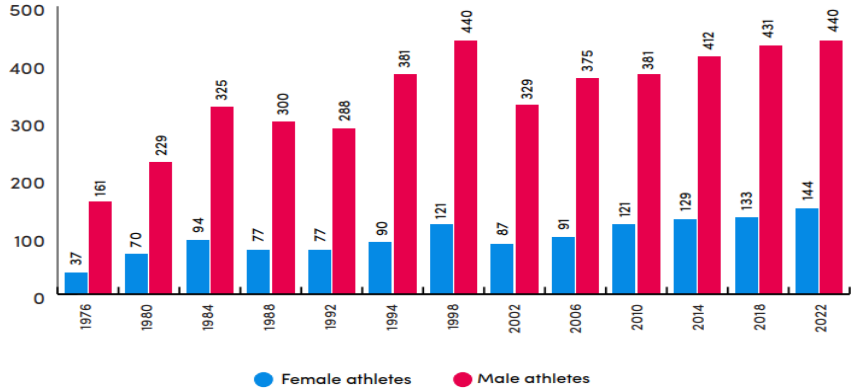
8 Casey Atkins, Barriers for Women with Disabilities in Sport and The Benefits (2021) https://www.ideas.org.au/blogs/barriers-for-women-with-disabilities.html (last visited on Dec 16, 2024)

If this impact is brought through empowerment of disabled sportswomen, it will create social change.

IPC views gender equity in sports as priority. In this regard, in the year 2003 it formed specific committee namely Women in Sports Committee (WISC). More specific roles of the WISC include:

• Raise the voice for the full inclusion of women at all levels of Paralympic sport; Recognize the obstacles that hinder participation and propose initiatives and policies to overcome these barriers; and • Follow up the implementation of initiatives to increase participation. .[10]

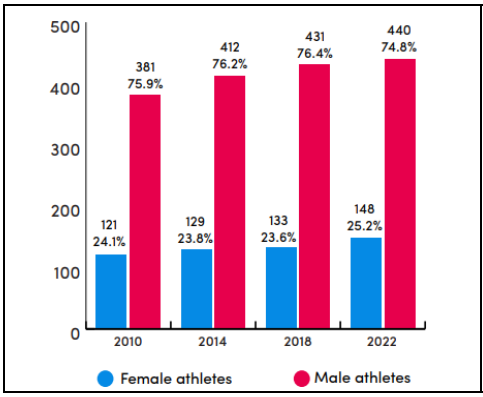
Figure 1 : Number of Male and Female Athletes in the Paralympic Winter Games, 1976-2022



Source: Data released by A Women's Sports Foundation Research Report, December 2022

Figure 1 data highlights the smaller number of female participation in para sports throughout. Till 2022 the number of female participation has not gone beyond 25% as compared to male counterpart. Although in the history of paralympic games female participation reached a new high the but at slow pace. In 2022, there were total 46 countries in the Paralympic Winter Games, out of which 16 countries did not include women in their athlete delegation.[11] There is an requirement to increase the number of women's events and enhance participation in these events.

Fig 2: The number and percentage of female and male athletes in the paralympic winter games 2010-2022



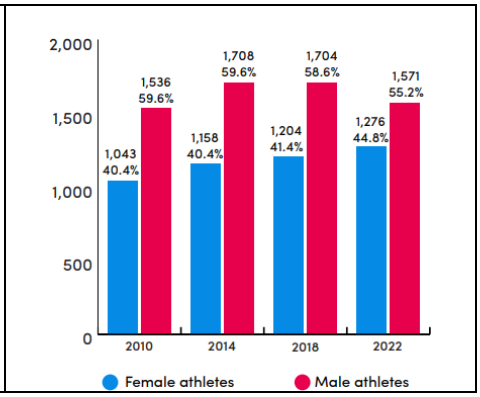


Fig 3: The number and percentage of female and male athletes in the Olympic winter games 2010-2022

Source: Data released by A Women's Sports Foundation Research Report, December 2022

Figure 2 and 3 comparatively reflects that women representation in sports is less in both Olympics and Paralympics. In 2022, there is 25.2% disabled female participation in Paralympics whereas 44.8% female participation in Olympics.

[9] IPC. (2019). International Paralympic committee strategic plan 2019 to 2022 https://www.paralympic.org/sites/default/files/document/190704145051100_2019_07+IPC+Strategic+Plan_web.pdf (last visited on Dec 17, 2024)

[10] IPC, IPC Women in Sport Leadership Toolkit (2010) https://www.paralympic.org/sites/default/files/document/130130154714620_2010_10_01++IPC+Women+in+Sport+Leadership+Toolkit.pdf (last visited on Dec 17, 2024)

[11] E. Houghton, L. Pieper & M. M. Smith, (2022). Women in the 2022 Olympic and Paralympic Games: An Analysis of Participation, Leadership, and Media Coverage. Women's Sports Foundation.

India's Efforts

India is a party to the 'Incheon Strategy for the Asia-Pacific Decade of Persons with Disabilities (2013-2022)', formulated under the supervision of United Nation ESCAP. This strategy outlines ten goals for Asia-Pacific nations to promote the inclusion and empowerment of individuals with disabilities in the region. One such is ensuring gender equality and women's empowerment. Also the Department of Empowerment of Person with Disabilities (DoEPwD) released the draft National Policy for Persons with Disabilities 2021. The policy document focuses in-depth commitment **to education, skill development, health and sports and culture, employment, social security, accessibility and other institutional mechanisms.**[(12)]

The power of sports as a developmental tool is of particular importance for disabled women who frequently experience discrimination on the basis of sex and disability. It is estimated that only 7% of women with disabilities are involved in sports, globally. Therefore, by improving inclusion of PwDs, sports can help advance the Sustainable Development Goals (SDGs).[(13)]

Section 30 of Rights of Persons with Disabilities Act, 2016 (hereinafter as RPwD Act) also states that appropriate Government shall take measures to ensure effective participation in sporting activities of the persons with disabilities. It also lays that the sports authorities shall accord due recognition to the right of persons with disabilities to participate in sports and shall make due provisions for the inclusion of persons with disabilities in their schemes and programmes for the promotion and development of sporting talents. Section 4 lays that government shall take steps to ensure that women rights are enjoyed equally with others.

Some Steps for Empowerment of Disabled in Sports which will also specifically help disabled women.

- Draft of Rights of Persons with Disabilities (Amendment) Rules, 2023 on accessibility standards for sports sector were notified inviting comments from the general public and stakeholders recently by the DoEPwD, Ministry of Social Justice and
- Empowerment.
- The Government has laid the foundation stone for Centre for Disability Sports at Gwalior, Madhya Pradesh with world class facilities for both indoor and outdoor games and training facilities for about 300 persons with disabilities. It is expected to be functional soon this year.
- National Fund for Persons with Disabilities has been established as per Section 86 of the RPwD Act, 2016. Scheme for Providing Financial Assistance to Persons with Disabilities under National Fund includes support for PwDs who have excelled in sports level to participate in the National/International events.
- Khelo India are gender neutral scheme and provides opportunities to women too for participating in sporting activities and development of sports, leagues, competitions and tournaments for women, as well as other disadvantaged groups, may be organised in different disciplines at various levels.[(14)]

In April 2022, Internal Complaint Committee for Prevention of Sexual Harassment of women at Workplace has been established at Paralympic Committee of India. It is noteworthy here that classic example of leadership role is Deepa Malik who has been elected as president of the Paralympic Committee of India.

Few Instances of Challenges faced by Disabled Women in Sports

One of the incident is of M. Sameeha Barvin, who is deaf and speech impaired athlete. Despite her excellent performance, she was not selected to participate in the World Deaf Athletics Championship just for the reason of being only female participant. She also fought legal battle and than court directed to declare her as selected and permit her to participate in the 4th World Deaf Athletics Championship held at Poland under the women category. .[(15)]

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12 https://www.iasparliament.com/current-affairs/gs-ii/the-draft-national-policy-on-disability (last visited on Dec18, 2024)

13 Draft National Policy For Persons with Disabilities (Divyangjan), 2021 https://disabilityaffairs.gov.in/upload/uploadfiles/files/Draft%20Copy%20New%20National%20Policy%20May%2 02022%20.pdf (last visited on Dec 18, 2024)

14 Operational Guidelines, Khelo India Scheme 2021-22 to 2025-26 , Ministry of Youth Affairs and Sports https://kheloindia.gov.in/uploads/Khelo-India-Scheme-Operational-Guidelines.pdf (last visited on Dec 21, 2024) [15] M. Sameeha Barvin vs. The Joint Secretary, Ministry of Youth & Sports & Ors. (Writ Petition No.16953 of 2021)

- India's two leading and top ranked women para-athletes, Pooja Yadav and Sakshi Kasana, have alleged injustice at the hands of the Paralympic Committee of India regarding their selection for World Para-Athletics Grand Prix 2023.(16) The complaint of Pooja and Sakshi is with regard to deposit of 2.5 lacs with PCI. Both have put forward their complaints before office of Sports Ministry. Such incidents reflects lack of financial support to disabled women which discourages their participation at International level.
- There are certain sports areas which has no teams or participation by the disabled women. In future if any disable sportswomen/atheletes shows interest than it should be fully supported by all stakeholders. India's first women's disabled cricket team faced challenges which needs special mention.(17)

Findings & Discussion

The research findings reveal that India has made commendable strides in recognizing the rights of disabled women in sports. Legal provisions, such as the Rights of Persons with Disabilities Act, have laid the foundation for inclusive practices and non-discrimination. Government initiatives, sports organizations, and civil society efforts have contributed to creating avenues for disabled women's participation, skill development, and recognition in various sports disciplines. These advancements have played a pivotal role in empowering disabled women and challenging societal perceptions surrounding disability. There are initiatives by the government either for women or for persons with disabilities . But there is no specific initiatives for disabled women.

However, despite progress, several challenges persist. Barriers such as limited infrastructure accessibility, lack of awareness, social stigma, and inadequate support systems continue to hinder the full participation and empowerment of disabled women in sports. Financial constraints, limited opportunities for training and competition, and societal biases often create hurdles that need to be addressed to ensure a level playing field for disabled women athletes. Furthermore, the intersectionality of gender, disability, and other factors necessitates a nuanced approach that recognizes and addresses the unique challenges faced by different groups of disabled women.

Conclusion

In the contemporary scenario, the empowerment of disabled women through sports in India has witnessed significant progress, but challenges persist. This research paper has explored the topic of disabled women's empowerment in sports in India, highlighting the multifaceted nature of the issue and the complex interplay between disability rights, women's rights, and the sports landscape. Through a comprehensive analysis of legal sources, policies, and practices, this study has shed light on the current state of affairs and the opportunities for further advancement.

To further advance the empowerment of disabled women through sports in India, a comprehensive and multi-faceted approach is required. This includes the need for continued advocacy and awareness campaigns to challenge social norms and stereotypes surrounding disability. Investment in accessible infrastructure, specialized training programs, and coaching support is crucial to nurture talent and enable disabled women athletes to reach their full potential. Collaboration between government agencies, sports organizations, NGOs, and the private sector can help create a more inclusive and supportive ecosystem that fosters the empowerment of disabled women in sports.

In conclusion, while progress has been made, there is still work to be done to enhance the empowerment of disabled women through sports in India. By addressing the remaining barriers and implementing targeted interventions, India can build upon its achievements and create a more inclusive and equitable sports environment. Empowering disabled women in sports not only promotes their individual growth and well-being but also contributes to social inclusion, dismantles stereotypes, and fosters a society that embraces diversity and equality. It is through collective efforts and a rights-based approach that India can truly transform the contemporary scenario and provide disabled women with equal opportunities to thrive in the world of sports.

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16 Sabi Hussain, Top female para-athletes allege 'mental harassment' by PCI, Times of India(2023) http://timesofindia.indiatimes.com/articleshow/100194189.cms?from=mdr&utm_source=contentofinterest&utm_mediu m=text&utm_campaign=cppst (last visited on Dec 22, 2024)

17 Divya Arya, Undaunted by disability: Meet the 'superwomen' who play cricket against all odds, The Bridge (2019)https://thebridge.in/women-cricket/indian-disabled-women-cricketers-superwomen-40554?infinitescroll=1 (last visited on Dec 22, 2024)

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Review Article

From Doklam to Galwan: Strategic Standoff and the Future of India-China Border Relations

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Abstract

The India-China border dispute has remained one of Asia's most persistent geopolitical flashpoints. From the 2017 Doklam standoff to the violent Galwan Valley clash in 2020, the pattern of confrontation has reflected deeper strategic anxieties and a shift in bilateral relations. This paper investigates the evolution of India-China border tensions with a special focus on the events at Doklam and Galwan, analyzing the strategic, diplomatic, and military dimensions of the crisis. It assesses the implications of these standoffs on regional stability, India's foreign and defense policies, and the broader Indo-Pacific strategic architecture. The study uses qualitative content analysis based on official statements, media reports, satellite data, and scholarly commentary to evaluate the changing nature of the bilateral relationship. Recommendations for diplomatic re-engagement, military modernization, and regional coalition-building are proposed to address future challenges.

Keywords: India-China Relations, Doklam Standoff, Galwan Clash, Border Dispute, Strategic Tensions, LAC, Geopolitics, Indo-Pacific

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Introduction

India and China, two of the world's oldest civilizations and emerging superpowers, share a complex and contested history shaped by conflicting territorial claims, historical mistrust, and regional aspirations. The bilateral relationship between the two nations has witnessed frequent oscillations between cooperation and confrontation. Despite growing economic interdependence and participation in multilateral platforms such as BRICS, SCO, and RIC, the border dispute remains a central point of friction. The 3,488-kilometer-long Line of Actual Control (LAC), the de facto border between India and China, remains undefined and un-demarcated, leading to differing perceptions and recurrent standoffs.[1]

The confrontations at Doklam in 2017 and Galwan Valley in 2020 represent significant turning points in India-China relations. These two incidents were not merely isolated military standoffs but reflective of a broader strategic rivalry.[2] Doklam, situated at the tri-junction of India, Bhutan, and China, witnessed a 73-day military face-off following China's road construction attempt in a region claimed by Bhutan but patrolled by India.[3] India's intervention was seen as a strategic assertion to protect its own security and regional allies, especially in safeguarding the Siliguri Corridor, also known as the "Chicken's Neck" — a narrow stretch connecting mainland India to its northeastern states.

The Galwan clash in June 2020, on the other hand, marked the first fatalities on the India-China border since 1975 and was a stark reminder of the volatility that characterizes the LAC. The clash, which resulted in the deaths of 20 Indian soldiers and an undisclosed number of Chinese troops, profoundly altered the strategic calculations of New Delhi.[4] It exposed the inadequacy of existing confidence-building measures and questioned the utility of diplomatic dialogues that had so far helped maintain an uneasy peace. The Galwan incident shattered the illusion of a stable and managed boundary, revealing the depth of strategic mistrust and China's aggressive posturing under President Xi Jinping's leadership.[5]

These two crises underscore a critical reality: the India-China border dispute is no longer a dormant legacy of the 1962 war but a live wire in Asia's

[1] Ministry of External Affairs, Government of India. (2020). Statements and releases on India-China border.

[2] Singh, S. (2021). *Galwan and Beyond: The New China Challenge*. HarperCollins India.

[3] Baruah, A. (2018). "Doklam and the India-China Relations." *Journal of Asian Security*, Vol. 12(2).

[4] Ladwig III, W. (2020). "India and China at the Line of Actual Control." *International Affairs*, 96(2).

[5] Stobdan, P. (2020). *The Great Game in the Himalayas*. Penguin Random House.

geopolitics. China's assertiveness along the LAC is often seen in the context of its broader strategic objectives, including territorial expansionism, regional dominance, and deterrence of India's strategic partnerships with the United States and other Indo-Pacific powers.[6] India, on its part, has responded by recalibrating its strategic posture, strengthening infrastructure along the border, enhancing diplomatic outreach, and asserting its sovereignty through military preparedness and economic countermeasures.[7]

This paper explores the implications of these developments for the future of India-China relations. It seeks to analyze the evolution of the strategic standoff from Doklam to Galwan, understand the patterns of Chinese military behavior, and assess India's responses across military, diplomatic, and economic dimensions. The broader aim is to provide a framework for interpreting these confrontations not just as bilateral issues, but as part of a larger power struggle in Asia. The study aims to recommend pragmatic strategies that India can adopt to deter future aggression while engaging in credible diplomacy for long-term peace and stability along the LAC.

Research Methodology

The India-China border conflict has been extensively studied within the disciplines of international relations, strategic studies, and regional geopolitics. This review of literature focuses on the scholarly interpretations, strategic analyses, and policy evaluations surrounding the Doklam standoff (2017) and the Galwan Valley clash (2020), situating them within the broader theoretical and empirical frameworks of Sino-Indian relations.

1. Historical and Strategic Background

Several scholars provide a foundational understanding of the historical genesis of the India-China boundary dispute. John W. Garver's seminal work, Protracted Contest: Sino-Indian Rivalry in the Twentieth Century (2001), explores the legacy of the 1962 war and outlines the ideological and territorial elements shaping the rivalry. Garver emphasizes that the boundary conflict is embedded in broader strategic competition between the two rising powers, influenced by differing worldviews and strategic cultures.[8]

Similarly, Neville Maxwell's controversial account, India's China War (1970), argues that India's forward policy and lack of diplomatic engagement exacerbated tensions. Although criticized for being overly sympathetic to the Chinese narrative, Maxwell's work prompted a re-evaluation of India's strategic decisions during the early years of the conflict.

2. Doklam Standoff: Strategic Implications

The 2017 Doklam standoff attracted significant attention from Indian and international think tanks. Scholars such as Harsh V. Pant and Avinash Godbole (Observer Research Foundation, 2017) analyze the incident as a test of India's resolve in defending its strategic interests in Bhutan and the eastern Himalayas. Their findings suggest that India's intervention was a message to China and smaller South Asian nations that New Delhi would not tolerate unilateral attempts to alter territorial status quos.[9]

Shyam Saran, former Foreign Secretary of India, in his writings for the India Habitat Centre and The Print, emphasized the importance of Bhutan's sovereignty and the strategic vulnerability of the Siliguri Corridor. His assessment connects the standoff with India's larger concern about encirclement under China's Belt and Road Initiative (BRI).

Chinese scholars have interpreted the incident differently. Hu Shisheng and Zhang Jiadong (China Institute of Contemporary International Relations) framed the Indian intervention as a violation of Chinese sovereignty and indicative of India's hegemonic behavior in South Asia. This divergence in narratives reveals the deep mistrust between the two nations and the influence of nationalism in shaping policy and public opinion.[10]

3. Galwan Valley Clash: A Watershed Moment

The Galwan clash in June 2020 marked a major inflection point. According to Happymon Jacob (The Hindu, 2020; IPCS commentaries), the incident exposed the failure of existing conflict resolution mechanisms like the Working Mechanism for Consultation and Coordination (WMCC) and the Special Representatives' Dialogue. He argues that China's aggressive posture may be linked to its broader regional ambitions and an attempt to deter India from deepening ties with the United States and the Quad.[11]

C. Raja Mohan (Indian Express, 2020) interprets Galwan as a shift in China's behavior from ambiguity to assertiveness. He emphasizes the need for India to revisit its assumptions about China's commitment to a peaceful resolution and to prepare for a long-term strategic rivalry.[12]

The Lowy Institute and Brookings India have published reports asserting that the Galwan incident disrupted the previous status quo along the LAC and represents a new phase of militarized diplomacy. These studies stress that India must invest in border

[6] Institute for Defence Studies and Analyses (IDSA). (2021). "LAC Developments: Strategic Overview."

[7] ORF (Observer Research Foundation) Reports (2017-2021).

[8] Garver, J. (2001). *Protracted Contest: Sino-Indian Rivalry in the Twentieth Century*. University of Washington Press.

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[11] Jacob, Happymon. (2022). *Line on Fire: Ceasefire Violations and India–Pakistan Escalation Dynamics*. Oxford University Press. *(Relevant for comparative border management studies).*

[12] Mohan, C. Raja. (2021). *Samudra Manthan: Sino-Indian Rivalry in the Indo-Pacific*. Carnegie India / Brookings Institution Press.

infrastructure, satellite surveillance, and high-altitude warfare readiness.

4. Theoretical Interpretations

International relations theorists have analyzed the India-China conflict through multiple lenses. Realist scholars, including Mearsheimer (2001) and Rajesh Basrur (2021), argue that the conflict is a natural outcome of power transition in Asia, where rising powers seek to assert dominance and secure their peripheries. From this perspective, border tensions are manifestations of a larger strategic competition between two regional powers with incompatible ambitions.

On the other hand, constructivist scholars like Kanti Bajpai and Manjeet Pardesi have focused on the role of identity, historical memory, and nationalism. Bajpai (2020) argues that both nations carry unresolved psychological legacies of the 1962 war, which shape public opinion and elite discourse, making compromise difficult.

5. Policy Recommendations and Strategic Choices

Policy literature has explored options available to India post-Galwan. Authors like Jeff M. Smith (Cold Peace, 2021) and Arvind Panagariya (Columbia University) recommend a combination of military preparedness, economic decoupling, and regional coalition-building. They underscore the importance of enhancing ties with the U.S., Japan, Australia, and ASEAN to balance Chinese power in the Indo-Pacific.[13]

Indian government reports and white papers, including those by the Ministry of Defence (2021) and Ministry of External Affairs, emphasize the importance of maintaining dialogue while being prepared for any contingency. Parliamentary debates and Standing Committee reports highlight infrastructure gaps and intelligence coordination failures that need urgent redressal.[14]

The existing literature captures the complex and evolving nature of India-China border tensions, particularly through the lens of the Doklam and Galwan crises. While there is consensus that both standoffs mark a strategic shift, scholars differ in attributing causality — ranging from tactical provocations to structural power rivalry. What emerges clearly is that future peace and stability along the LAC will require not only military deterrence but also strategic foresight, diplomatic engagement, and regional coalition-building.

Research Gap

The India-China border dispute has been extensively studied through historical, geopolitical, and strategic lenses. Numerous scholarly works have explored the legacy of the 1962 war, the structural complexities of the Line of Actual Control (LAC), and the strategic rivalry between the two Asian powers. Incidents like the Doklam standoff (2017) and the Galwan Valley clash (2020) have received significant attention in policy analyses, think tank reports, and diplomatic commentaries. However, despite the proliferation of literature, there remain several key gaps that merit focused academic attention.

Firstly, comparative analysis between Doklam and Galwan has largely been treated in isolation, with limited attempts to assess these standoffs as connected milestones in an evolving pattern of Chinese strategic behavior. While each crisis has been studied individually, there is a lack of integrated research that evaluates their combined impact on India's border policy and regional security framework.

Secondly, much of the existing work is policy-centric or written from a military-strategic viewpoint, often lacking interdisciplinary depth. There is a need for more comprehensive research that intersects political science, diplomacy, international law, and regional studies, offering a nuanced understanding of the dispute beyond military calculations.

Third, limited scholarly work has assessed India's strategic recalibration—both military and diplomatic—after Galwan. Although media outlets and think tanks have documented India's infrastructural push and diplomatic alignments post-2020, academic studies evaluating the long-term implications of these shifts on regional power dynamics are relatively scarce.

Fourth, China's evolving tactics and strategic intent remain under-theorized in Indian academic discourse. Most existing analyses are reactive and descriptive rather than predictive or theoretical. There is room for deeper exploration of China's border strategy in the context of Xi Jinping's vision of rejuvenated nationalism, military modernization, and the Belt and Road Initiative (BRI).

Finally, grassroots perspectives, such as the impact of the standoff on border communities, local economies, and civil-military relations, are rarely incorporated into the mainstream discourse, leaving the socio-cultural dimensions underexplored.

Addressing the Gap

This study attempts to address these gaps by:

- Offering a comparative and integrated analysis of Doklam and Galwan.
- Situating the standoffs within the broader strategic architecture of Asia.
- Evaluating India's evolving response mechanism across military, diplomatic, and economic spheres.
- Proposing recommendations that incorporate theoretical, practical, and people-centric dimensions for future policy.

Problem of the Study

Despite decades of diplomatic dialogue and confidence-building measures, the India-China border remains a volatile and unpredictable zone. The absence of a clearly demarcated Line of Actual Control (LAC), differing strategic worldviews, and military build-ups has made peace tenuous. The problem lies in understanding why these standoffs recur despite talks and what strategic adjustments India needs to make to safeguard its interests. This

[13] Smith, Jeff M. (2021). *Cold Peace: China–India Rivalry in the Twenty-First Century*. Lexington Books.

[14] Ministry of Defence, Government of India. (2021). *Annual Defence Reports and White Papers* https://mod.gov.in/

study seeks to identify the patterns and consequences of border standoffs and evaluate their implications for India's security and foreign policy.

Research Methodology

This research adopts a qualitative and analytical methodology to examine the strategic dynamics and evolving nature of the India-China border dispute, with specific focus on the Doklam (2017) and Galwan (2020) standoffs. The study is primarily based on secondary sources, including academic journals, strategic think tank publications, government documents, media reports, and official statements from both India and China. A comparative case study approach has been employed to analyze the two crises, assessing similarities and differences in strategic intent, diplomatic narratives, military engagement, and geopolitical consequences. This methodology allows for a deeper understanding of how each incident reflects broader shifts in regional security and foreign policy.

Content analysis of public statements, speeches by political and military leaders, and parliamentary reports has been used to interpret India's evolving strategic posture. Similarly, Chinese white papers, PLA (People's Liberation Army) commentaries, and articles from Chinese state media have been reviewed to understand China's position and military assertiveness. Strategic frameworks such as realism, power transition theory, and the security dilemma have been used to analyze the behavior of both states within the international system.

The research also utilizes thematic coding to categorize the findings into broader areas: historical grievances, strategic signaling, diplomatic engagement, and future implications. Data triangulation has been ensured by cross-verifying information from multiple reputable sources, including the Ministry of Defence (India), MEA briefings, Brookings India, Carnegie Endowment, and Lowy Institute reports. The research avoids ethnocentric or nationalist biases and aims to maintain objectivity in assessing both nations' perspectives. While the study is limited to secondary data, the depth of strategic and diplomatic documentation allows for a comprehensive and credible analysis. The methodology thus supports a well-rounded, evidence-based understanding of the present and future trajectory of India-China border relations.

Objectives of the Study

1. To analyze the historical and geopolitical context of India-China border tensions.
2. To examine the strategic implications of the Doklam and Galwan standoffs.
3. To evaluate India's diplomatic and military response to Chinese assertiveness.
4. To identify long-term trends in bilateral relations post-Galwan.
5. To recommend strategic and policy measures for conflict prevention and management.

Findings and Analysis

The comparative study of the Doklam (2017) and Galwan (2020) standoffs reveals a significant transformation in the strategic and diplomatic contours of the India-China border relationship. One of the key findings is the shift in China's strategic behavior from ambiguous assertiveness to overt militarizationof disputed territories.In Doklam, China attempted to unilaterally alter the status quo by constructing a road in territory claimed by Bhutan, thereby challenging Indian security interests in the Siliguri Corridor. India's measured yet firm military intervention, based on its treaty obligations with Bhutan and its own strategic calculations, demonstrated a willingness to directly counter Chinese advances without crossing into actual combat.

In contrast, the Galwan Valley clash in 2020 marked a more serious escalation. Unlike Doklam, where the confrontation was confined to diplomatic channels and a show of force, Galwan involved direct physical violence, resulting in fatalities — the first in over four decades. The Galwan incident shattered several assumptions: that India and China had reliable confidence-building measures in place, and that economic engagement between the two nations served as a deterrent to armed conflict. The analysis shows that China's aggression in Galwan was premeditated, with evidence of fortified military build-up and deviation from previously agreed disengagement protocols. This indicates a deliberate attempt by Beijing to test India's resolved and limits its strategic outreach in Ladakh and the Indo-Pacific.

The findings also point to India's significant strategic recalibration following Galwan. There has been a surge in infrastructure development along the LAC, deployment of additional troops, and enhanced surveillance and air defense systems in sensitive areas. Diplomatically, India has intensified its engagement with Quad members (U.S., Japan, Australia), redefined its economic policy towards China through banning apps and limiting FDI from neighboring countries, and raised the issue in international forums more assertively than before.

Another important observation is the failure of existing diplomatic and military mechanisms such as the Working Mechanism for Consultation and Coordination (WMCC) and the Special Representatives Dialogue. Both failed to prevent conflict escalation or manage the aftermath in an effective or timely manner. The absence of mutual trust and clarity in LAC demarcation continues to plague the bilateral relationship, resulting in prolonged disengagement negotiations and a frozen diplomatic dialogue.

The analysis further reveals a broader geopolitical dimension to these border standoffs. China's actions can be seen in the light of its ambition to establish hegemony in Asia, deter India from aligning with Western powers, and secure strategic advantage in contested terrains. India, on the other hand, is emerging as a more assertive regional player, unwilling to tolerate territorial encroachment and actively seeking strategic counterbalances.

In conclusion, both Doklam and Galwan are not isolated incidents but rather symptoms of a larger strategic rivalry rooted in unresolved territorial disputes, competing regional aspirations, and shifting global alliances. The findings suggest that unless a new framework of engagement — based on clarity,

reciprocity, and deterrence — is established, the LAC will continue to be a flashpoint in Asia's geopolitics.

Recommendations

To address the recurring tensions along the Line of Actual Control (LAC) and to build a more stable India-China relationship, a set of multi-dimensional and forward-looking policy recommendations is essential. These should encompass diplomatic, military, strategic, and developmental approaches.

1. Strengthen Border Infrastructure and Surveillance: India must continue to accelerate the development of all-weather roads, bridges, helipads, tunnels, and communication infrastructure in border areas, particularly in Ladakh, Arunachal Pradesh, and Sikkim. Enhanced infrastructure not only ensures troop mobility but also improves the supply chain and logistics during stand-offs. Satellite surveillance, UAV deployment, and real-time intelligence-sharing between security forces must be prioritized.

2. Institutionalize Robust Conflict Management Mechanisms: The existing bilateral conflict resolution mechanisms have proven inadequate. Therefore, both countries should upgrade or replace the Working Mechanism for Consultation and Coordination (WMCC) with a time-bound, accountable, and transparent system. An independent Joint Verification Mission or LAC Observation Commission could be established to investigate and mediate border incidents.

3. Enhance Diplomatic Engagements with Strategic Clarity: India should engage China through both bilateral and multilateral platforms with a clear articulation of its red lines. While diplomatic dialogue must continue, India should also build strategic coalitions through forums like the Quad and Indo-Pacific alliances to balance China's assertiveness. Regular people-to-people interactions, academic exchanges, and Track II diplomacy may help reduce misperceptions and build long-term trust.

4. Develop an Integrated LAC Policy Doctrine: India must formulate a comprehensive LAC doctrine that integrates military readiness, economic countermeasures, cyber-security preparedness, and psychological operations. This doctrine should serve as a guide for civil-military coordination, inter-agency collaboration, and strategic communication in times of border crises.

5. Promote Local Community Development in Border Areas: Empowering border communities through livelihood generation, education, and healthcare services enhances national security. Civilian presence acts as a natural deterrent to foreign encroachments. India must invest in border village development schemes to increase local resilience and patriotic participation.

6. Long-term Strategic Dialogue on Boundary Settlement: India and China must reinitiate structured boundary talks aimed at achieving a lasting settlement. This will require political will, mutual compromise, and third-party verification mechanisms. While difficult, a peaceful resolution is essential for regional stability and economic cooperation in Asia.

These recommendations aim to transform India's border strategy from reactive to proactive, ensuring national security, strategic stability, and diplomatic credibility in the face of evolving geopolitical challenges.

Conclusion

The Doklam standoff in 2017 and the Galwan Valley clash in 2020 have emerged as defining moments in the trajectory of India-China border relations. These incidents mark a shift from passive border management to active confrontation, reflecting the deepening strategic mistrust between the two Asian powers. While Doklam showcased India's willingness to defend allied interests in Bhutan and protect the Siliguri Corridor, Galwan revealed the fragility of peace mechanisms and the dangers of Chinese unilateralism in disputed regions. Both events exposed the limitations of past diplomatic frameworks and underlined the need for a recalibrated strategic posture.

The analysis confirms that India-China tensions are not merely border-specific but are embedded in broader geopolitical rivalries, ideological differences, and regional power competition. China's assertiveness, seen through rapid military infrastructure build-up and violation of established protocols, indicates a shift in Beijing's regional strategy. On the other hand, India's post-Galwan response — including military preparedness, diplomatic realignment, and economic countermeasures — signifies a more assertive and strategic approach.

For the future, maintaining peace and stability along the Line of Actual Control will require a combination of strong deterrence and sustained diplomacy. India's focus must remain on building resilient border infrastructure, formulating a cohesive LAC policy, and strengthening strategic alliances in the Indo-Pacific. Simultaneously, efforts toward meaningful boundary dialogue must be revived with transparency and mutual respect.

In conclusion, while immediate conflict may be averted through disengagement and de-escalation, long-term peace can only be achieved through structural reforms in the bilateral relationship. The India-China border issue, as highlighted through Doklam and Galwan, serves as a powerful reminder that strategic vigilance, diplomatic foresight, and national unity are imperative for securing India's sovereignty and regional stability in the evolving Asian order.

Way Forward

The future of India-China relations, particularly in the context of their contested border, depends on a pragmatic mix of realism, resilience, and strategic foresight. While the Doklam and Galwan incidents have deeply strained trust, they also offer a vital opportunity for India to reassess and reshape its long-term security and diplomatic strategies.[15]

First, India must adopt adual-track approach: pursue tactical deterrence while maintaining open channels for high-level diplomatic dialogue. Strengthening military readiness along the Line of Actual Control

[15] CRS Report for U.S. Congress (2021). *China-India Border Tensions: Strategic Outlook*.

(LAC) with modernized infrastructure, surveillance systems, and rapid response capabilities must remain a top priority. Simultaneously, India should continue to emphasize dialogue under clearly defined red lines, ensuring that diplomacy is not seen as a sign of weakness but as a strategic necessity.

Second, a comprehensive LAC policy framework must be institutionalized, integrating the efforts of the armed forces, the Ministry of External Affairs, intelligence agencies, and local governments. This policy should include socio-economic development in border areas, enhanced civil-military cooperation, and proactive community engagement to solidify India's presence in vulnerable regions.

Third, India must enhance strategic partnerships in the Indo-Pacific and South Asia through platforms like the Quad, BIMSTEC, and bilateral defense agreements. These alliances will serve not only as force multipliers but also as geopolitical signals that India is not isolated in its strategic concerns regarding China.

Finally, there is a need to invest in long-term conflict prevention through academic exchange, cultural diplomacy, and confidence-building measures involving retired diplomats, scholars, and civil society groups from both nations.

In essence, the way forward lies in a balanced posture — one that blends strategic firmness with diplomatic agility, ensuring India's sovereignty and regional influence remain intact amidst an uncertain and evolving geopolitical landscape.

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Review Article

The Impact of Artificial Intelligence on Health Sciences Training and Assessment

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Abstract

Artificial Intelligence (AI) is reshaping health sciences education by transforming traditional training methodologies and assessment strategies. The rapid advancements in AI technologies offer unprecedented opportunities to enhance medical and healthcare training, addressing challenges related to knowledge acquisition, skill development, and competency evaluation. AI-driven tools, such as intelligent tutoring systems, virtual patients, and adaptive learning platforms, enable personalized education by tailoring instructional content to individual learning needs. By analysing student performance and learning patterns, AI facilitates targeted interventions, improving comprehension, retention, and clinical proficiency. Simulation-based training powered by AI has revolutionized experiential learning by providing immersive, interactive environments where students can practice clinical decision-making and procedural skills in a risk-free setting. Virtual and augmented reality simulations, along with AI-assisted robotic training, enhance surgical and diagnostic proficiency, preparing healthcare professionals for real-world clinical scenarios. Additionally, AI-driven automated assessment methods improve the objectivity and efficiency of evaluations, supporting competency-based education through real-time feedback and performance analytics. Beyond training and assessment, AI contributes to interdisciplinary learning and enhances collaborative medical education by integrating data-driven insights and predictive analytics. However, the adoption of AI in health sciences education also raises ethical and practical concerns. Issues such as data privacy, algorithmic bias, the digital divide, and the evolving role of educators in AI-enhanced learning environments require careful consideration. Moreover, challenges related to technological infrastructure, integration with existing curricula, and the need for faculty training must be addressed to ensure the effective implementation of AI-driven educational solutions. This review examines the current applications, benefits, and challenges of AI in medical and health sciences education, providing a comprehensive analysis of its transformative impact. Finally, the discussion explores future directions, emphasizing the potential for AI to create a more efficient, accessible, and learner-centered educational landscape, ultimately shaping the next generation of competent and innovative healthcare professionals.

Keywords: Artificial Intelligence, Education, Health Sciences, Medical, Learning, Training

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Introduction

The rapid advancements in Artificial Intelligence (AI) have profoundly influenced multiple industries, with health sciences education being no exception [(1)]. As the healthcare landscape grows increasingly complex, the demand for innovative and efficient educational strategies has intensified [(2)]. Traditional teaching methods, while effective, often struggle to meet the evolving needs of modern medical education, particularly in terms of individualized learning, real-time assessment, and hands-on clinical training [(3)] [(4)]. AI has emerged as a transformative force, offering new opportunities to enhance the way medical students and healthcare professionals acquire knowledge, develop skills, and assess competencies [(5)].

AI-powered tools such as adaptive learning systems, intelligent tutoring systems, and automated assessment platforms are redefining traditional educational methodologies by delivering personalized, data-driven learning experiences [(6)]. These technologies analyze student performance, provide customized feedback, and adjust instructional content in real-time to accommodate individual learning needs [(7)]. By incorporating AI into medical training, institutions can optimize knowledge retention, improve diagnostic reasoning, and enhance the overall learning process [(8)].

Beyond personalized instruction, AI has revolutionized experiential learning through the integration of virtual and augmented reality (VR/AR), predictive analytics, and natural language processing (NLP) [(9)]. AI-driven simulation-based training, for example, allows students to engage with virtual patients, practice clinical decision-making, and refine procedural techniques in a risk-free

environment [10]. AI-assisted robotic simulations and haptic feedback technologies further enhance surgical training, allowing medical trainees to develop precision and motor skills before performing procedures on real patients [11]. Additionally, AI-powered automated assessment tools improve the objectivity and efficiency of evaluations, ensuring that students meet required competencies through continuous performance tracking and real-time feedback [12].

Despite its promising benefits, AI adoption in health sciences education is not without challenges. Ethical concerns regarding data privacy, bias in AI algorithms, and the changing role of educators in AI-assisted learning environments must be carefully addressed [13]. The reliance on vast amounts of student data raises questions about confidentiality, security, and ethical use, necessitating strict regulatory frameworks [14]. Additionally, AI models trained on biased datasets may lead to inequitable assessments or reinforce disparities in medical education. Furthermore, integrating AI into existing curricula requires technological infrastructure, faculty training, and institutional support, posing challenges for widespread implementation, particularly in resource-limited settings [15].

This article provides a comprehensive review of the current applications of AI in health sciences training and assessment, highlighting its potential benefits, challenges, and future implications. By examining AI's role in personalized learning, simulation-based training, competency assessment, and clinical decision-making, this review aims to offer insights into how AI can shape the future of health sciences education. Additionally, it explores the ethical considerations, implementation challenges, and long-term impact of AI on medical education, ultimately addressing its role in preparing the next generation of skilled and competent healthcare professionals.

AI in Health Sciences Training

The integration of Artificial Intelligence (AI) in health sciences education is transforming the way students and professionals acquire medical knowledge and clinical skills. AI-driven tools facilitate interactive, data-driven, and personalized learning experiences that improve comprehension, retention, and practical application. The following sections explore key areas where AI is enhancing health sciences training:

AI enables a customized educational experience by analysing student performance and adapting learning content accordingly. Machine learning algorithms track individual learning patterns, identify strengths and weaknesses, and recommend targeted resources such as readings, videos, and interactive modules [16]. Adaptive learning platforms provide real-time feedback, allowing students to progress at their own pace and focus on areas needing improvement [17]. This personalized approach enhances knowledge retention and optimizes the learning process for each student.

AI-powered virtual simulations and AR applications provide immersive, interactive learning experiences that bridge the gap between theoretical knowledge and clinical practice [18]. Virtual patients, AI-generated case scenarios, and AR-based anatomical models enable students to practice clinical decision-making, diagnostic reasoning, and procedural techniques in a risk-free environment. These tools enhance experiential learning by replicating real-life medical situations, allowing students to apply their skills without the risk of harming actual patients [19]. Additionally, AI-driven simulations can adapt based on student performance, presenting increasingly complex cases to challenge and refine clinical competencies [20].

AI-powered chatbots and intelligent tutoring systems serve as virtual instructors, offering instant guidance, explanations, and assessments. These tools engage students by answering queries, identifying knowledge gaps, and providing customized learning pathways [21]. AI-driven tutors can simulate Socratic questioning techniques, prompting students to think critically and refine their problem-solving abilities. Moreover, natural language processing (NLP) enables AI tutors to understand and respond to complex medical inquiries, making them valuable assistants in self-directed learning and exam preparation.

AI-assisted robotic simulations are revolutionizing surgical education by providing realistic, hands-on training environments [22]. AI-driven haptic feedback mechanisms enable medical students and professionals to develop fine motor skills, precision, and hand-eye coordination for complex surgical procedures[23]. Virtual reality (VR) surgical simulators, enhanced by AI algorithms, allow learners to practice a range of procedures, from basic suturing techniques to intricate robotic-assisted surgeries [24]. These simulations also provide real-time performance analysis, highlighting errors and offering corrective feedback to improve surgical competence. As AI continues to evolve, it holds the potential to refine procedural training, minimize human errors, and enhance patient safety [25].

AI in Health Sciences Assessment

Artificial Intelligence (AI) is transforming assessment methodologies in health sciences education by automating grading, providing real-time feedback, and enhancing the evaluation of clinical competencies. AI-driven assessment tools offer greater objectivity, efficiency, and scalability, ensuring that students are evaluated based on their knowledge, skills, and professional competencies [26]. The following sections explore key areas where AI is improving assessment in health sciences education:

AI-based assessment tools leverage natural language processing (NLP) and machine learning algorithms to evaluate a variety of student responses, including written assignments, clinical case analyses, and practical examinations [27]. These tools can assess the coherence, accuracy, and depth of responses, providing instant feedback that helps students refine their understanding and improve their performance. AI-driven grading systems also ensure consistency in evaluation, reducing biases that may arise in traditional manual assessments [28]. Furthermore, speech recognition and AI-driven simulations allow for automated assessment of verbal responses in clinical scenarios,

improving the efficiency of oral exams and patient interaction assessments [29].

AI facilitates competency-based education by continuously tracking students' progress in acquiring clinical skills. By analysing performance data from practical exercises, virtual simulations, and case-based assessments, AI identifies individual strengths and areas for improvement [30]. This real-time tracking ensures that students master essential competencies before advancing to more complex levels of training. AI-driven analytics also help educators personalize instruction, focusing on skill gaps and optimizing the learning experience. Additionally, predictive analytics can forecast student performance trends, enabling early intervention for those struggling with specific competencies.

AI is enhancing Objective Structured Clinical Examinations (OSCEs) by integrating computer vision, deep learning, and speech analysis to assess students' interactions with standardized patients and clinical scenarios. AI-powered systems can analyze nonverbal cues such as facial expressions, eye contact, and body language, as well as verbal elements like tone of voice and medical communication skills [31]. This technology enables comprehensive evaluations of students' ability to demonstrate empathy, professionalism, and effective patient communication. Additionally, AI-driven virtual standardized patients allow students to engage in dynamic, responsive clinical encounters that adjust based on their performance, offering a more personalized and scalable OSCE experience.

AI-powered remote proctoring systems play a crucial role in maintaining academic integrity during online assessments. These systems utilize facial recognition, keystroke dynamics, eye-tracking, and behavioural analysis to detect potential cases of academic dishonesty [32]. AI can identify suspicious activities, such as unauthorized resource usage, multiple individuals in the testing environment, or unusual answer patterns, helping educators uphold fair and secure examination conditions. Additionally, AI-driven proctoring tools reduce the need for human invigilators, making online assessments more accessible and cost-effective while ensuring reliability and security.

Challenges and Ethical Considerations

Despite the numerous benefits of Artificial Intelligence (AI) in health sciences education, its integration presents significant challenges and ethical concerns. These issues must be carefully addressed to ensure that AI-driven educational tools enhance learning without compromising fairness, security, or accessibility.

AI-powered educational tools rely on vast amounts of student data to personalize learning experiences, track progress, and improve assessment accuracy. However, the collection, storage, and analysis of such data raise concerns about confidentiality, security, and ethical use. There is a risk of data breaches, unauthorized access, and misuse of student information, which could compromise privacy. Institutions must implement robust data protection policies, comply with regulations such as the General Data Protection Regulation (GDPR) and the Health Insurance Portability and Accountability Act (HIPAA), and ensure transparency in data usage to maintain student trust.

AI models are trained on historical data, which may contain biases related to gender, ethnicity, socioeconomic background, and other factors. If these biases are not addressed, AI-driven assessments and personalized learning recommendations may unintentionally favor certain student groups over others, leading to unfair evaluations. For example, AI algorithms trained on datasets from a specific demographic may struggle to accurately assess students from diverse backgrounds. To mitigate this issue, AI systems must be regularly audited for bias, trained on diverse and representative datasets, and designed with fairness and inclusivity in mind [33].

The implementation of AI-driven educational tools requires substantial financial investment in infrastructure, software, and ongoing maintenance. Institutions with limited budgets, particularly those in low-resource settings, may struggle to afford these technologies, creating disparities in access to AI-enhanced education. Additionally, students from underprivileged backgrounds may have limited access to the necessary devices and internet connectivity to fully benefit from AI-powered learning. To bridge this gap, policymakers and educational institutions must explore cost-effective solutions, such as open-source AI platforms and public-private partnerships, to make AI-driven education more accessible and equitable [34].

The successful integration of AI in health sciences education depends on educators' ability to effectively utilize AI tools within the curriculum. Many faculty members may lack the technical expertise or confidence to implement AI-driven teaching methods, leading to resistance or ineffective use of these technologies [35]. Comprehensive faculty development programs, including hands-on training, workshops, and ongoing support, are essential to help educators understand AI's potential, address their concerns, and integrate it seamlessly into their teaching practices. Additionally, fostering a collaborative approach between AI developers and educators can ensure that AI tools are designed with practical, user-friendly applications in mind [36].

To fully harness the potential of Artificial Intelligence (AI) in health sciences education, future efforts must address existing challenges while advancing AI's capabilities to create more equitable, effective, and ethical learning environments. The following key areas should be prioritized to ensure AI's responsible and impactful integration into medical and health sciences training:

Ensuring transparency in AI decision-making processes is crucial for building trust and reliability in AI-driven education. Future developments should focus on creating explainable AI (XAI) models that allow educators and students to understand how AI algorithms generate assessments, recommendations, and feedback [37]. Additionally, proactive measures must be taken to minimize algorithmic bias by diversifying training datasets, continuously monitoring AI systems for fairness, and implementing bias-correction techniques. Establishing standardized guidelines for ethical AI

usage in education can further promote fairness and accountability.

To bridge the digital divide and ensure that AI-powered education benefits a wider audience, efforts should focus on developing cost-effective, scalable AI solutions. Open-source AI platforms, cloud-based AI applications, and AI-powered mobile learning tools can make these technologies more accessible to institutions with limited resources. Collaborations between governments, private organizations, and academic institutions can drive initiatives that subsidize AI-based education for underprivileged communities. Additionally, leveraging AI for offline learning solutions, such as AI-driven adaptive textbooks and offline chatbot tutors, can enhance accessibility in regions with limited internet connectivity.

While AI can enhance learning and assessment, human expertise remains indispensable in health sciences education [38]. Future advancements should emphasize the complementary role of AI and human educators, ensuring that AI serves as a supportive tool rather than a replacement for faculty. AI can automate repetitive tasks, provide real-time feedback, and analyze performance trends, while educators focus on mentorship, critical thinking development, and ethical decision-making [39]. Hybrid AI-human teaching models should be designed to preserve the essential human elements of empathy, clinical reasoning, and professional judgment in medical training [40].

The continuous evolution of AI in health sciences education requires collaboration across disciplines, including medicine, computer science, psychology, and education. Future research should explore how AI can enhance problem-based learning, interprofessional education, and hands-on clinical training [41]. Additionally, interdisciplinary efforts should focus on improving AI's ability to simulate complex patient interactions, enhance diagnostic reasoning, and facilitate real-time decision-making support for students. Establishing global research networks and knowledge-sharing platforms can accelerate the development of innovative AI applications tailored to the needs of health sciences education.

By addressing these future directions, AI can be leveraged to create a more personalized, efficient, and inclusive educational landscape that better prepares future healthcare professionals for the evolving demands of the medical field.

Conclusion

Artificial Intelligence (AI) is fundamentally transforming health sciences education by enhancing training methodologies and assessment strategies. Through personalized learning, immersive simulations, and automated evaluations, AI-driven tools are revolutionizing how healthcare professionals acquire knowledge, develop clinical skills, and demonstrate competencies. By leveraging machine learning, natural language processing, and advanced data analytics, AI enables more efficient, interactive, and adaptive learning experiences, ultimately improving the quality of medical education. However, despite its promising benefits, AI integration in health sciences education is not without challenges. Issues such as data privacy, algorithmic bias, cost barriers, and faculty preparedness must be carefully addressed to ensure that AI-driven education remains fair, ethical, and widely accessible. Strategic implementation, guided by ethical considerations and continuous monitoring, is essential to maximizing AI's potential while mitigating risks. Educational institutions, policymakers, and technology developers must collaborate to establish best practices for responsible AI adoption in medical training.

As AI technologies continue to evolve, their role in health sciences education will expand, fostering a new era of competency-based learning, enhanced clinical decision-making, and data-driven assessment. By embracing AI responsibly, the medical education community can cultivate a new generation of highly skilled, adaptable, and patient-centered healthcare professionals who are prepared to meet the challenges of modern medicine.

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Review Article

Metallic Nano-oxides and their Attributes in Agricultural Traits and Sustainability for Future Food industries.

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Abstract
The continuous degradation of soil over time has led to reduced crop productivity and lower nutritional value, largely due to the excessive use of traditional fertilizers, which are not only expensive but also environmentally harmful and unsustainable. In recent years, nanoparticles have emerged as promising tools in agriculture, offering a sustainable approach to soil restoration. These nanoscale materials have shown potential as fertilizers because they are more easily absorbed and utilized by plants compared to their conventional, bulk forms. Despite this promise, there is still limited research detailing the role of nanoparticles in crop nutrition and protection. This review aims to shed light on the use of nanosized nutrients such as, iron, and titanium nano-oxide, as fertilizers and growth promoters. It also highlights the importance of adopting nanomaterials to reduce reliance on toxic agrochemicals, while discussing the wide-ranging advantages of nanoparticles, including enhanced plant growth and increased resistance to diseases.

Keywords: Nanoparticles, Environment, Agriculture, Food Industry

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Introduction

1. Nanoparticles and environment.

Nanotechnology is rapidly emerging across various fields, and the unique size-dependent properties of nanomaterials have opened the door to innovative applications. These nanoscale materials often behave very differently from their larger counterparts in the environment, leading to distinct environmental pathways and interactions. With their increasing use in consumer products, nanomaterials offer promising solutions to long-standing challenges. However, their widespread application also raises concerns about potential unforeseen environmental and health risks, especially in the area of nanotoxicity. (1) The situation is further complicated by the absence of comprehensive regulations governing the use of nanomaterials. Key environmental concerns include accidental releases, atmospheric deposition, deliberate environmental applications (such as in pesticides and soil remediation), the use of nanomaterial-containing soil additives (like manure and sludge), and contaminated irrigation water. (2)

Recent research has highlighted the potential advantages of using nanoparticles (NPs) in agriculture. Nanotechnology holds the promise to transform the agricultural sector by introducing advanced tools to improve crop productivity. This evolving field, known as agri-nanotechnology, focuses on optimizing the use of essential agricultural resources like water, nutrients, and agrochemicals through highly efficient nanoparticle-based products such as nanopesticides. Additionally, nanosensors have been developed not only to detect pests but also to monitor and regulate soil nutrient levels and water stress. This contributes to more efficient fertilizer use and helps reduce environmental pollution. (3)

Among the various types of engineered nanomaterials, metal oxide nanoparticles (MONPs) are some of the most widely produced and utilized. Due to their distinctive chemical, electronic, and optical characteristics, they are commonly used across multiple sectors. However, their solubility and tendency to release metal ions can potentially increase their environmental impact. (4, 5)

2. The characteristics of nano-oxide particles involved in fate of plants

The beneficial or harmful effects of metal oxide nanoparticles (MO NPs) on seed germination, plant growth, and morphology are largely influenced by how these nanoparticles behave and persist in the plant growth environment. These outcomes are determined by internal factors such as the NPs'

chemical composition, size, shape, surface properties, reactivity, and applied dose. They are also shaped by external or environmental factors, including the type of growth medium, method of application, nanoparticle aging, plant species, and the specific localization of MO NPs within plant tissues. (6)

Particle size plays a critical role in enabling nanoparticles to penetrate plant cells. Transport across the plasma membrane is facilitated by ion channels and transporter proteins. Once inside the cell, nanoparticles can interact directly with organelles involved in oxidation, like mitochondria and chloroplasts, or with nutrient transport pathways, including biomolecules and pores. Generally, plants allow nanoparticles ranging from 20 to 50 nm in size to move into and accumulate within their cells. (7)

For MO NPs that are relatively soluble, both size and shape significantly influence their dissolution rate due to differences in surface area-to-mass ratios. Smaller nanoparticles possess a higher specific surface area, greater saturation solubility, and a thinner diffusion layer compared to larger ones—factors that accelerate their dissolution. Once dissolved, the resulting metal ions can affect cellular functions by binding to cell components and altering their activities. These metal ions can also drive biochemical reactions that may lead to phytotoxic effects and negatively influence plant physiology. (8)

Even without entering plant cells, the toxicity of MO NPs can still be substantial. Their solubility can modify the ionic balance in the immediate surroundings of the cell–nanoparticle interface, which may also result in toxic effects. (9)

3. Impact of different metallic nano-oxides on the growth and development of Crops.

3.1 Iron Oxide nanoparticle

Iron oxide nanoparticles (Fe_2O_3 NPs) are extensively used across multiple sectors such as catalysis, bioengineering, and medicine. Over time, they find their way into agricultural ecosystems primarily through wastewater discharge and atmospheric emissions. As with many nanoparticles, some level of phytotoxicity toward plants is expected. However, numerous studies suggest that Fe_2O_3 NPs can actually have beneficial effects on plants—particularly in rice cultivation. (10) Research indicates that these nanoparticles can enhance rice seed germination, alleviate oxidative stress caused by environmental stressors, and support overall plant growth. In adverse soil conditions, such as those with iron deficiency or drought, Fe_2O_3 NPs have been successfully employed as nano-fertilizers to improve the development of rice seedlings. (11) In a 2013 study, Alidoust et al. reported that iron oxide nanoparticles coated with citric acid (measuring 6 nm) could accelerate rice root elongation and exhibited lower toxicity compared to micron-sized iron oxide under reducing soil conditions. Since then, interest in the use of Fe_2O_3 NPs for improving rice seed germination has grown significantly. (12) One notable example involves iron oxide nanoparticles synthesized from *Cassia occidentalis* L. flower extract. These nanoparticles were found to penetrate the rice seed coat, suppress seed dormancy, enhance starch metabolism, and significantly boost germination—especially in sensitive, early-flowering mutant rice strains exposed to environmental stress. (13)

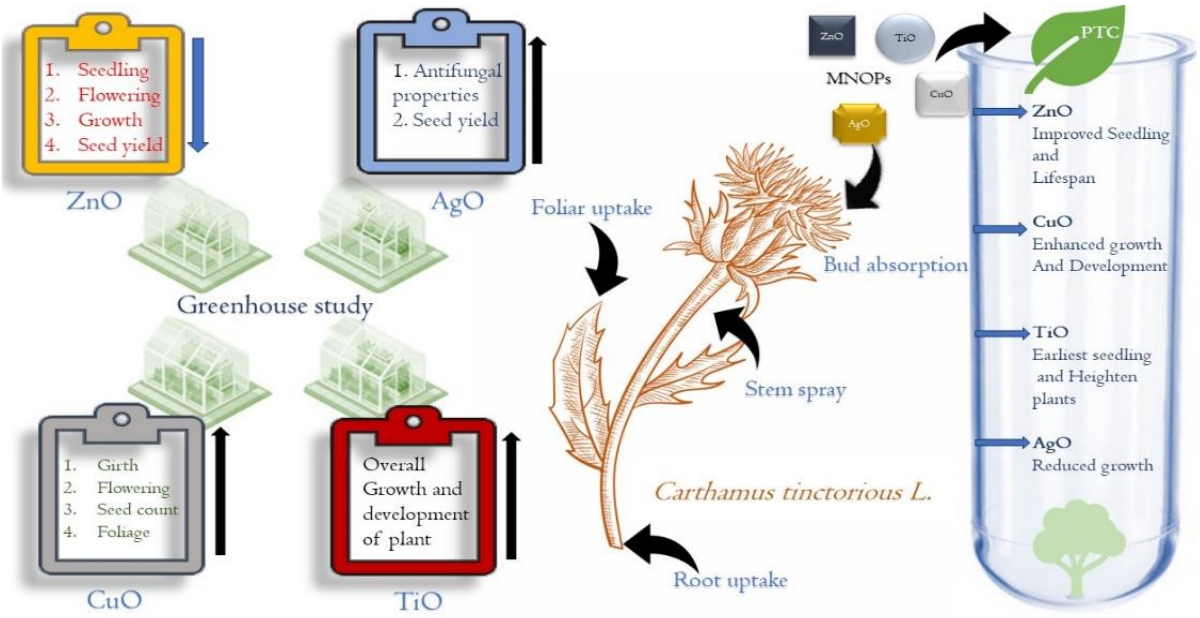

Figure: 1 Greenhouse study and Impact of different metallic nano-oxides on the growth and yield of safflower. Permission from the Ref. (24)

Figure 2. (a) Representation of iron-oxide-nanoparticle-treated germination in rice. permission from Ref. [12]. 2021, Springer-Verlag; (b) rice growth response. Reprinted with permission from Ref. [14]. 2017, American Chemical Society.

Table: 1. Impact of Iron Metal Nano-oxides on the growth of Rice crop. (Ref. 28)

Particle Size	Concentration of MNO	Exposure time	Observed Effects	Reference
8 nm	500, 1000, 2000 mg/L	10 weeks	Stimulated the development of rice root systems.	[10]
18 nm	20, 40 mg/L	22 hours	Enhanced α-amylase activity and starch breakdown, leading to improved seed germination and seedling strength.	[12]
<12 nm	20 mg/L	21 days	Under calcium stress, improved productivity, electron transport in photosynthesis, antioxidant activity, and iron uptake.	[14]
20–25 nm	50, 250, 500 mg/L	3 weeks	Reduced oxidative stress in iron-deficient rice; enhanced growth and regulated iron-related plant hormones.	[11]
14.1 nm	2000 mg/L	5 days	Promoted seedling growth and increased chlorophyll and antioxidant levels; reduced toxicity from 3-nitrophenol.	[15]
10–50 nm	0.0025 mg/kg	40 days	Boosted chlorophyll and potassium content, reducing stress caused by cadmium (Cd) and sodium (Na).	[17]
70–100 nm	10, 20, 30 mg/L	4 weeks	Improved biomass and iron levels in rice; helped lower cadmium accumulation.	[16]
18–94 nm	25, 50, 100 mg/kg	30 days	Enhanced biomass, antioxidant enzyme production, and photosynthetic function; reduced ROS levels and tolerance to cadmium and drought.	[18]
Not Available	40, 320 mg/L	6 days	Increased dry weight of rice and facilitated cadmium transport and accumulation in plant tissues.	[23]
5–10 nm	125 mg/kg	25 days	Lowered lead concentrations in rice roots and shoots.	[19]
21.3 nm	200 mg/L	7 days	Prevented arsenic transfer to above-ground plant parts, aiding in detoxification.	[20]
60–80 nm	5, 10, 15 ppm	7 days	Suppressed arsenic uptake while promoting overall plant growth.	[21]
20–30 nm	25, 50 mg/L	21 days	Enhanced iron absorption and improved resistance to oxidative stress; lowered arsenic accumulation in rice.	[22]

3.2 *Titanium nano-oxides*

Most studies to date have focused on treating seeds, particularly during the early stages of plant development. Some of these growth experiments have been conducted using Hoagland's nutrient solution (hydroponics) or in agar-based media. However, these studies often overlook the potential interactions between nanoparticles (NPs) and soil components. In contrast, research on foliar application of nanoparticles is limited and still not well understood. Recently, seed priming has emerged as a promising method to enhance seed vigor, improve germination uniformity, and support seedling growth under stressful environmental conditions. As a result, the influence of titanium dioxide (TiO_2) nanoparticles on seed germination has been extensively studied. Most of this research involves applying TiO_2 nanoparticle suspensions to seeds placed on moistened filter paper in Petri dishes, assessing their effects on germination and root development. (25)

Depending on the concentration used, TiO_2 nanoparticles can have either a stimulating or inhibiting effect. For example, when naturally aged spinach seeds were exposed to rutile-form TiO_2 NPs at concentrations between 250 and 4000 mg/L, a significant increase was observed in germination rate, germination index, seedling dry weight, and vigor index. However, higher concentrations (6000 and 8000 mg/L) led to a decline in these parameters. Similarly, canola seeds treated with various TiO_2 NP concentrations (10–2000 mg/L) showed enhanced germination and seedling vigor only at the 2000 mg/L concentration, while lower concentrations had no noticeable effect (26). TiO_2 nanoparticles appear to

exhibit relatively low toxicity; however, the experimental methods used across studies have been inconsistent, leading to conflicting results. It is challenging to compare findings from different sources due to variations in how the nanoparticle suspensions were prepared, differences in particle size, and the specific allotropic form of TiO_2 used—factors that vary significantly between studies. (27)

4. Nano-oxides influence over seed germination.

To ensure a sustainable future for agriculture, it is crucial to adopt environmentally responsible seed treatment practices. Sustainable seed treatments aim to balance profitability, environmental protection, and social equity—benefiting both current and future generations. One key aspect of this approach is regulating the use of agrochemicals, as their uncontrolled application can lead to soil and water contamination, harm to non-target organisms (including plants, animals, birds, and aquatic life), and disruption of ecosystems. (30)

When used for seed treatment, agrochemicals can leach into surrounding soil and water bodies, eventually entering the food chain and accumulating in living organisms. Excessive use not only leaves harmful residues on crops but also contributes to nutrient imbalances and diminished quality of agricultural products. Moreover, overuse poses serious environmental risks—accelerating climate change, reducing biodiversity, polluting groundwater and soil, depleting natural resources, and causing air, noise, and waste-related pollution. To address these challenges, sustainable agricultural practices must be developed and promoted. A promising solution is the use of smart agrochemicals for seed treatment. These advanced formulations are designed to deliver nutrients efficiently, enhance crop yields, and reduce environmental harm, thereby supporting the goals of sustainable agriculture. (31,32)

5. Future outlook

A thorough understanding of the impact of metal oxide nanoparticles (MO NPs) on plants is crucial, particularly given their increasing production and widespread application in agriculture. Toxicological studies have shown noticeable phytotoxic effects of MO NPs, but these typically occur at concentrations much higher than those likely to be found in natural environments or required for agricultural use. The behavior and biological activity of MO NPs are largely influenced by soil properties, such as pH, organic matter content, and clay composition. However, many phytotoxicity studies are conducted using hydroponic systems or soil-less media, which may not accurately reflect real-world conditions. The most meaningful and reliable results come from tests conducted in natural soil under environmental conditions. Therefore, more long-term studies evaluating the effects of low concentrations of MO NPs in soil-based systems are needed.

Comparing findings across different studies remains difficult due to variations in experimental design. To address this, a more standardized and systematic approach is necessary—one that clearly defines all relevant parameters. This is important because both the inherent characteristics of nanoparticles and environmental factors can significantly influence outcomes. More significantly, metal oxide nanoparticles (MONPs) have considerable potential in the growing nano-fertilizer market. However, their application must be carefully managed—strict regulations should govern both the timing and frequency of use, and their composition should be regularly monitored through testing. It is essential to minimize any unintended damage to crops that could result from incorrect application or excessive dosages.

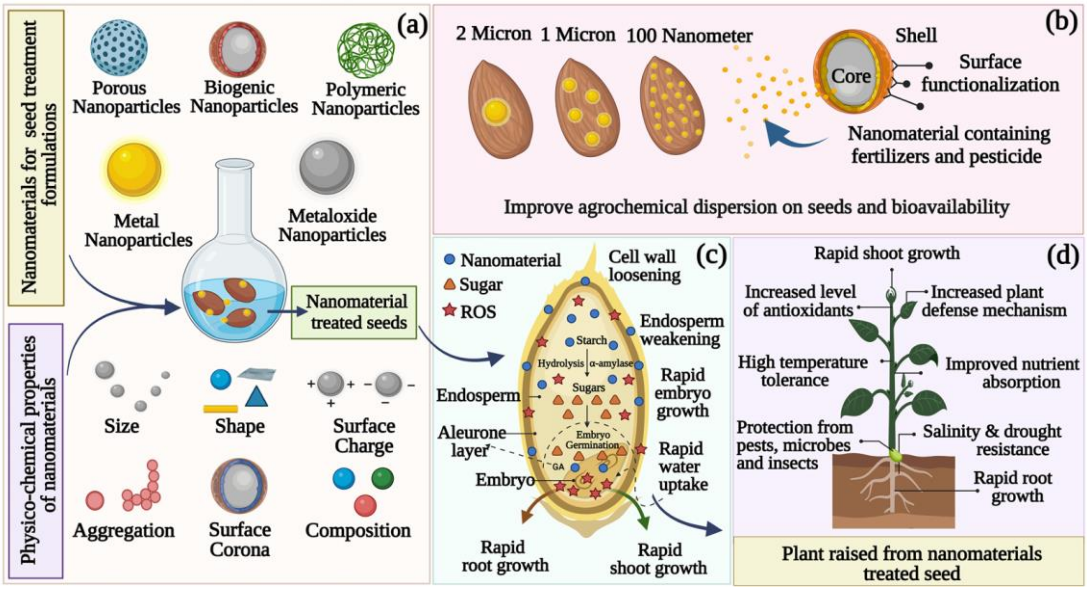

Figure 3. Type and impact of nanoparticles on seed germination, growth and metabolism. Fig taken from Ref. (29) for better understanding of metallic nano-oxide type and influence mechanism on seed growth.

Furthermore, when translating laboratory research into practical agricultural use, it is crucial to consider real-world environmental factors. These include the actual release levels of MONPs into the environment, their long-term stability, and the cumulative effects of natural elements such as wind, temperature fluctuations, rainfall, and drought.

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Review Article

Contemporizing Urban Digital structure with Edge Computing in Smart metropolises

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Abstract

Modern cities are being forced to transform into intelligent, networked systems known as "smart cities" due to the increasing dependence on data-intensive technology and the fast and constant growth of metropolitan populations. These urban environments require sophisticated infrastructures that can enable real-time data collecting, analysis, and automated decision-making in fields such as transportation management, energy distribution, environmental monitoring, healthcare, and public safety. However, traditional centralized cloud computing architectures are becoming unable to fulfill the rigorous requirements for ultra-low latency, high dependability, localized processing, and data privacy in such scenarios.A fundamental concept for overcoming these limitations is edge computing, which moves storage and processing power closer to data-generating sources at the edge of the network. Through improved responsiveness, bandwidth conservation, data secrecy, and system resilience, this method lessens reliance on remote cloud servers. Because of this, edge computing is essential to the development of scalable, effective, and flexible smart city infrastructures.This study provides a detailed analysis of edge computing within the context of smart urban settings. It describes the technology aspects and building blocks required, looks at application-specific implementations in important industries, and emphasizes the operational and infrastructure benefits that edge-based deployments offer. The research also cites significant integration problems, including interoperability and deployment costs, as well as security concerns and energy limits. It also investigates emerging themes such as edge artificial intelligence, 5G integration, and decentralized edge services via blockchain. Urban planners, technology architects, academics, and policymakers working to create sustainable, adaptable, and future-ready urban ecosystems will find this study to be a useful resource.

Keywords: Urban Digital Structure, Edge Computing, Block chain

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1. Introduction

A new age of intricate potential and problems for cities throughout the world has been brought about by urbanization in the twenty-first century. Cities are producing enormous amounts of data from electricity meters, traffic signals, surveillance systems, environmental sensors, and individual mobile devices as a result of the growth of the Internet of Things (IoT) and the proliferation of linked gadgets. The need for computerized adaptability especially real-time analytics has increased, especially in fields like supply of energy, public safety, disaster recovery, and transportation logistics.

Conventional cloud-centric computing models process data by sending it to distant data centers. This architecture involves considerable latency, bandwidth inefficiencies, and potential privacy risks, despite being effective for large-scale processing and storage. In time-sensitive smart city applications, these restrictions are becoming more and more intolerable.

A new paradigm change has been offered by edge computing. Edge systems improve robustness, facilitate decentralized processing, and decrease latency by bringing figuring out farther from an information source. This study investigates the function of edge computing in the overall picture of smart cities by looking at usage scenarios, architectural considerations, advantages, drawbacks, and new developments[(1)].

Smart city projects have gained global acceptance as metropolitan regions are under greater strain to improve sustainability, efficiency, and safety. Distributed sensors, real-time analytics, and automated decision-making are key components of these projects. Traditional cloud computing approaches, on the other hand, are frequently hampered by network latency, capacity constraints, and privacy issues. Edge computing overcomes these limitations by decentralizing data processing to edge nodes near data sources, such as traffic lights, surveillance cameras, or power grids. In smart cities, where vital services like traffic management, emergency response, and environmental monitoring necessitate real-time processing and action, edge computing is especially pertinent. The function of edge computing in urban digital ecosystems and how it changes smart city architectures are explored in this article.

2. Edge Computing in Smart Cities[(2)]

A typical edge computing architecture for smart cities consists of the layers listed below:

IoT sensors, RFID tags, smart meters, and mobile devices that produce raw data are all part of the sensing layer.

• **Edge Layer:** Made up of mini servers or edge devices (such as routers or gateway) located at the edge of the network.

• **Fog Layer(Optional):** By serving as a link between the edge and the cloud, the fog layer (optional) manages more intricate calculations and analytics.

• **Cloud Layer:** Used for deep neural network training models, historic evaluation, and long-term storage.

Qualities:

Processing with low latency, real-time analytics, context-aware computation, and energy-efficient operation

3. Applications of Edge Computing in Smart Cities[3]

3.1 Astute Traffic Control

Real-time vehicle and pedestrian monitoring, adaptive traffic signaling, and congestion predictions are made possible by edge-based surveillance and sensor data. For example, edge nodes are able to immediately alert central offices when they notice crashes or accidents.

3.2 Smart Energy Grids:

Demand-response management, scheduled upkeep, or distributed energy efficiency are made possible by edge computing. Local edge processors may evaluate power use trends in real time to balance load and avoid disruptions.

3.3 Security and Monitoring

Facial recognition, anomaly detection, and emergency warnings necessitate low latency processing. Edge sensors at city crossroads or public buildings can detect dangers and provide immediate notifications in milliseconds.

3.4 Waste and water management

Edge-capable IoT devices may monitor garbage levels or water quality at several sites and notify service personnel in real time, increasing operational ency and environmental compliance.

3.5 Environmental Surveillance

Edge-connected sensors continually record temperature changes, noise levels, and pollution levels. The data that has been analyzed assists both long-term urban planning and quick corrective action.

4. Edge computing's benefits in urban ecosystems

Benefit	Description
Decreased Latency	Ensures quicker decision-making through local data processing.
Efficiency of Bandwidth	Reduces the amount of data sent to centralized cloud services.
Improved To lower privacy threats	Valuable information might be handled locally.
Resilience in Operations	Even during cloud failures, edge nodes continue to operate.
Scalability	Keeps centralized computers from being overloaded while supporting an increasing number of devices.

5. Considerations and Difficulties

5.1 Costs of Equipment and Installation

Initial deployment of edge nodes and distributed systems requires substantial capital expenditure, particularly in big cities.

5.2 Security and Data Integrity.

The protection of edge nodes against cyberattacks becomes crucial when data is handled at several places. Encryption, secure boot, and anomaly detection must be built into edge designs.

5.3 Compatibility

Communication between edge devices must occur across several platforms and protocols. Respecting cutting-edge computing and standards for the Internet of Things is crucial.

5.4 Use of Energy

While being more effective than cloud-based models, edge nodes still use electricity. Energy-efficient hardware and dynamic power management methods are required.

6. Upcoming Patterns and Research Paths

6.1 AI on the Boundaries

The combination of lightweight artificial intelligence models with edge computing will improve predictive analytics, anomaly detection, and autonomous control in urban systems.

6.2 Blockchain-Powered Perspective

Blockchain can facilitate transparent and safe communication between edge devices, particularly in areas like distributed energies trade, smart contracts, and authentication of identity.

6.3 5G Integration[4]

The low latency and high bandwidth of 5G will speed up edge computing capabilities in dense urban contexts, allowing for applications such as driverless cars and immersive AR/VR.

6.4 Edge-as-a-Service(EaaS)

Service providers may supply edge resources on demand, resulting in a new ecosystem for urban computing similar to cloud service models.

7. Conclusion

Edge computing enables quicker, more secure, and scalable digital services, it has the potential to revolutionize smart cities. It provides the framework for in-the-moment decision-making in critical infrastructure areas. The transition from centralized cloud computing to distributed edge architectures becomes not only preferable but also required as the variety of gadgets with internet access skyrockets and urban populations increase. Cities may develop into really intelligent systems that are durable, effective, and citizen-focused with careful design, strong execution, and continuous study.

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Review Article

Community Journalism as a Catalyst for Grassroots Development in Viksit Bharat@2047

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Abstract

This paper explores the transformative role of community journalism in advancing the vision of Viksit Bharat@2047, a national goal that envisions India as a developed, inclusive, and equitable society by 2047. Community journalism defined by localized storytelling, participatory media practices, and grassroots engagement serves as a bridge between policy makers and the people, particularly in rural and marginalized communities. Through platforms such as community radio, hyperlocal newspapers, and mobile-based reporting tools like *CGNet Swara*, *Khabar Lahariya*, and *Azad Hind Radio*, citizens are not only informed but empowered to voice concerns, demand accountability, and influence governance. This paper presents case studies, literature review insights, and government policy analysis to examine how community media aligns with Sustainable Development Goals (SDGs), bridges the urban-rural communication divide, and addresses challenges like digital illiteracy and media exclusion. It also recommends policy interventions, training, and digital innovations to strengthen community journalism. As India progresses toward Viksit Bharat, community journalism emerges as a strategic tool for inclusive communication, participatory democracy, and sustainable development.

Keywords: Viksit Bharat@2047, Community Journalism, Grassroots Development, Community Radio, Azad Hind Radio, SDGs, and Digital India

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Introduction

The vision of Viksit Bharat@2047 represents India's long-term national goal to transform itself into a developed nation by the year 2047, marking 100 years of India's independence. It is not merely an economic or political ambition but a holistic developmental blueprint that emphasizes inclusive growth, technological advancement, social equity, sustainable development, and citizen empowerment.

Under this vision, the Government of India outlines a future where every citizen regardless of caste, class, gender, or geography can participate meaningfully in the country's progress. Key focus areas included poverty eradication and social justice, universal access to quality education and healthcare, empowered rural communities and self-reliant villages, digital India and technological innovation, green and sustainable development and participatory governance and democratic engagement.

To achieve these objectives, media participation become vital components. This is where community journalism plays a pivotal role, acting as a bridge between government policies and public participation.

In a vast and diverse country like India, mainstream media often overlooks rural voices and marginalized communities. Community journalism, especially through mediums like community radio, hyperlocal news platforms, and grassroots digital collectives, provides a platform for such voices to be heard, their issues to be highlighted, and their solutions to be documented.

As India moves toward 2047, empowering local communities through participatory media becomes essential to ensure that development is not just top-down but also bottom-up. By enabling informed citizenship, local accountability, and cultural expression, community journalism aligns directly with the vision of Viksit Bharat@2047.

Grassroots development is a bottom-up approach that involves active participation from local communities in identifying their needs, planning, and implementing development initiatives. In Viksit Bharat@2047, grassroots development is essential for rural India's upliftment, poverty reduction, gender equity, clean environment, education, and employment. Community journalism, community radio, hyperlocal newspapers, and digital storytelling platforms help mobilize communities, monitor policy implementation, and encourage local innovation, making grassroots development a catalyst for achieving inclusive and sustainable goals.

Community journalism refers to a form of journalism that is produced by, for, and about local communities, especially those that are geographically confined, culturally distinct, or socially marginalized. Unlike mainstream or corporate media, which often focus on national or global issues, community journalism centers on local stories, local voices, and local impact.

It is typically characterized by:

- Hyperlocal content focusing on the immediate needs and concerns of a specific community
- Active involvement of community members as contributors, reporters, and even decision-makers
- Use of accessible media platforms, such as community radio, neighborhood newspapers, local newsletters, WhatsApp bulletins, and digital portals in regional languages A participatory approach to news production and dissemination

Community journalism emphasizes the democratization of media where media is not just a tool of information, but a platform for empowerment, dialogue, and development. It plays a critical role in civic engagement, making local populations aware of their rights, entitlements, and opportunities.

In the context of Viksit Bharat@2047, community journalism becomes a transformational medium that can bridge the information gap between government policies and grassroots realities. By amplifying underreported issues such as lack of access to healthcare, rural infrastructure, education, women's empowerment, or environmental degradation community journalism supports inclusive development. In this sense, community journalism is both a mirror and a messenger reflecting the community's needs while enabling progress from within.

India's Viksit Bharat@2047 vision focuses on inclusive and participatory development, requiring grassroots involvement in rural and semi-urban areas. Traditional media often overlooks rural issues and marginalized voices. Community journalism, acting as a bridge between policy and people, is emerging as a powerful tool for social transformation. Platforms like community radio, local newspapers, and digital citizen journalism are empowering rural voices and promoting accountability. However, scholarly attention on community journalism's role in Viksit Bharat@2047 remains limited.

Therefore, this research seeks to:

- Explore the impact and potential of community journalism in facilitating grassroots development
- Understand how it can amplify marginalized voices and local governance mechanisms
- Examine its contribution to media literacy, civic engagement, and participatory communication

By doing so, this study aims to highlight the strategic relevance of community journalism as a transformative force in achieving an inclusive and empowered Viksit Bharat.

Literature Review

- These works encompass citizen journalism platforms, community radio, ICT tools, and social impact studies in India:

While existing literature robustly documents the effectiveness of community journalism in empowerment, problem resolution, and civic engagement, there is limited work connecting these media practices directly with the unified national vision of Viksit Bharat@2047 and its broader developmental targets (e.g., SDGs, rural equity, digital inclusion). Community journalism as an essential strategy within India's 2047 vision

No.	Paper & Year	Focus / Findings
1	Mudliar, Donner & Thies (2012) – *Emergent Practices Around CGNet Swara*	Explores CGNet Swara's voice forum: over 70k calls, 1,100 messages, highlighting inclusive rural participation and citizen autonomy.
2	**Pain (2017)** – *Framing Citizen Activism: CGNet Swara vs Mobile Voices*	Comparative study showing citizen journalism as both activism and journalism, mobilizing communities across cultural contexts.
3	**Moitra, Kumar & Seth (2021)** – *Impact Pathways of Mobile-based Community Media*	Case study of Mobile Vaani: maps Theory of Change, evidences empowerment of marginalized groups via voice platforms.
4	**Mehta (2020)** – *Impact-driven Journalism during Pandemic*	Documents CGNet Swara's crisis reporting during COVID-19: ~90 stories, ~60% resolved, showcases high-impact outcomes.
5	**Biswal (2020)** – *Exploring Role of Citizen Journalism in Rural India*	Demonstrates digital participatory culture and critical consciousness within CGNet Swara via Arnstein's participation ladder.
6	**Goswamy & Kashyap (2018)** – *Community Radio for Agriculture Extension*	Identifies community radio as a vital participatory tool for disseminating agricultural innovation among rural farmers.
7	**Sharma (2023)** – *Community Radio for Rural Entrepreneurship*	Shows community radio's role in sustaining local industries by showcasing indigenous artisans and entrepreneurs.
8	**Khabar Lahariya (2009–)** – Recognized by UNESCO & The Hindu	Highlights an all-women rural newspaper that fosters local accountability and amplifies marginalized voices.
9	**Chalchitra Abhiyaan (2016–)** – collective using film/journalism in West UP	Documents grassroots media as cultural intervention, enabling storytelling and critical dialogue in riot-affected regions.
10	**Bultoo Radio / CGNet Swara Bluetooth (2015)**	Innovative 'Bultoo Radio' via Bluetooth: 528 stories in months, ~21,000 transfers, reaching media-dark tribal zones.

framework, advocating for integrated policies and scalable media models.

Community Journalism in India: An Overview

Community journalism in India has evolved from pre-independence India, where local newsletters and handbills played a crucial role in mobilizing public opinion and promoting social reform. Post-independence, journalism became institutionalized and centralized, with urban elites dominating the media landscape. The emergence of community radio in the 1990s and 2000s, along with the digital era and hyperlocal journalism, has further boosted community journalism. Notable platforms include Khabar Lahariya, CGNet Swara, and Mobile Vaani and Video Volunteers. Community media in India is increasingly recognized for its role in development planning, participatory governance, and digital inclusion, with government schemes like BharatNet and Digital India indirectly supporting community media ecosystems.

Platforms and formats

Community journalism in India uses various platforms and formats to address local populations' information needs. Print media, community radio, digital platforms, and hyperlocal news platforms are essential tools for low-literacy regions. Digital platforms like CGNet Swara, Mobile Vaani, and Video Volunteers empower non-literate communities to contribute actively to the public sphere. Hyperlocal news platforms focus on neighborhood-specific content, creating media ecosystems close to the people they serve. These platforms embody participatory communication and contribute to an inclusive and developed India.

Government Schemes and Support for Community Journalism

The Indian government has implemented various policies and schemes to strengthen community journalism, particularly through the Ministry of Information and Broadcasting (MIB). These include the Community Radio Policy, which allows educational institutions to run community radio stations, and the Media Infrastructure Development Scheme (MIDS), which provides grants-in-aid to new and existing stations, content generation support, and capacity-building workshops. The BharatNet project aims to provide high-speed internet to 2.5 lakh Gram Panchayats, supporting digital community journalism platforms like CGNet Swara, Mobile Vaani, and Video Volunteers. The Digital India campaign promotes digital literacy, e-Governance access in rural areas, and vernacular content creation by local communities. The Ministry of Electronics and Information Technology (MeitY) supports Common Services Centres and Information Kiosks at the panchayat level, indirectly helping in community reporting and digital storytelling. State-level initiatives, such as Bultoo Radio and Khabar Lahariya, have also supported community journalism through funding, policy facilitation, and recognition of local media organizations. Strengthening these policies will be essential for leveraging community media as a strategic tool in achieving the participatory development goals of Viksit Bharat@2047.

Role of Community Journalism in Grassroots Development

Community journalism is crucial for grassroots development by amplifying local voices, highlighting region-specific issues, promoting local governance, enhancing media literacy, and encouraging civic engagement. It bridges the urban-rural communication divide, empowers women, youth, and marginalized communities, and contributes to the inclusive vision of Viksit Bharat@2047.

Case Study 1: Khabar Lahariya – Rural Women-Led Media Initiative

Khabar Lahariya is a groundbreaking rural media organization led by Dalit and marginalized women in Uttar Pradesh and Madhya Pradesh. Launched in 2002, it began as a local-language newspaper and later evolved into a digital-first platform producing hard-hitting investigative journalism. Reporters cover gender-based violence, corruption, and local governance in areas often ignored by mainstream media. Their work has led to action on numerous issues, including road repairs and police accountability. The initiative not only amplifies unheard voices but also empowers rural women through media training, employment, and visibility, making it a model of inclusive journalism aligned with grassroots development goals.

Case Study 2: CGNet Swara – Mobile-Based Journalism in Tribal Areas

CGNet Swara is a mobile-based citizen journalism platform launched in 2010 to serve tribal populations in Chhattisgarh and neighboring states. It allows users in remote areas to report news and grievances via a simple voice call, which are then moderated by journalists and shared online. The platform addresses issues such as health, education, forest rights, and infrastructure. CGNet Swara has successfully resolved thousands of complaints, including teacher absenteeism and delayed wages. By using basic mobile technology, it bridges digital divides and ensures tribal communities have a voice in public discourse, directly contributing to grassroots empowerment and participatory governance.

Case Study 3: Azad Hind Radio 90.0 FM – Regional Community Radio Station

Azad Hind Radio 90.0 FM, based in Meerut, is a regional community radio station established to foster localized communication and development. The station broadcasts content on health, education, women empowerment, and local governance in Hindi and regional dialects, targeting rural and semi-urban listeners. It promotes government schemes, records community feedback, and creates platforms for villagers to share success stories and grievances. By engaging local volunteers Azad Hind Radio enhances civic participation and grassroots awareness. Its programming reflects real community concerns, thereby contributing to the broader goals of inclusivity and development under the Viksit Bharat@2047 vision.

Challenges and Limitations

Community journalism faces financial sustainability challenges, political and institutional barriers, lack of adequate training and infrastructure, poor internet connectivity, outdated equipment, and studio facilities. These issues hinder its full impact on grassroots development. Community journalists often come from marginalized backgrounds, affecting content quality and consistency. The rise of misinformation and fake news complicates the situation, necessitating robust fact-checking systems and media literacy programs to maintain trust and credibility.

Community Journalism in the Vision of Viksit Bharat@2047

Community journalism aligns with India's Sustainable Development Goals by promoting quality education, gender equality, and strong institutions. It plays a strategic role in Digital Bharat by enabling local storytelling and awareness campaigns. Policy recommendations for empowering community journalists include simplified licensing processes, funding schemes, regional training centers, and legal protections. Future innovations may include AI-powered local language reporting, immersive digital storytelling, and mobile-first journalism tools, boosting inclusivity and equipping rural reporters for Viksit Bharat@2047.

Conclusion

Community journalism is a crucial grassroots movement for inclusive development and participatory democracy. It amplifies local voices, promotes transparency, and empowers marginalized groups. Initiatives like Khabar Lahariya, CGNet Swara, and Azad Hind Radio demonstrate its transformative power. However, challenges like financial constraints, political pressure, limited training, and misinformation risks need policy-level support. Initiatives like Digital India and BharatNet align community media with India's Sustainable Development Goals, ensuring no voice is left unheard.

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Review Article

Real Time Monitoring and Very Efficiently Management System To Control Campus Using AI and IoT

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Abstract:

This paper presents a real-time monitoring and campus management system leveraging Artificial Intelligence (AI) and the Internet of Things (IoT). The proposed system enables centralized control and intelligent decision-making for managing energy consumption, security, environmental conditions, and occupancy. The integration of AI with IoT sensors enhances responsiveness and predictive maintenance, ensuring operational efficiency across educational institutions. The resolution enhancement techniques using transforms like DT-CWT, Curvelet, and Gabor filters further optimize image-based surveillance and monitoring. Experimental results show improved clarity and reduced noise in high-resolution satellite images critical for real-time monitoring.

Keywords:. IoT, Artificial Intelligence, Campus Management, Real-time Monitoring, DT-CWT, Curvelet Transform, Gabor Filter, Image Resolution Enhancement.

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Introduction: The rapid growth of smart technologies has transformed the landscape of campus operations across educational institutions. With the integration of Artificial Intelligence (AI) and the Internet of Things (IoT), campus environments can now be managed more efficiently, securely, and sustainably. Traditional systems often rely on manual interventions and isolated monitoring, which are inefficient and prone to errors. In contrast, real-time monitoring powered by AI and IoT offers intelligent automation, seamless data acquisition, and dynamic decision-making(1).

This paper proposes a novel approach to campus management that combines AI algorithms with IoT-enabled sensor networks to create a responsive and adaptive control system. Key applications include automated energy management, environmental sensing, smart surveillance, access control, and predictive maintenance. Additionally, high-resolution image enhancement using advanced techniques like Dual-Tree Complex Wavelet Transform (DT-CWT), Curvelet Transform, and Gabor filters enables accurate visual monitoring and analysis.

By leveraging the synergistic capabilities of AI and IoT, the system not only reduces operational costs and energy consumption but also enhances safety, user comfort, and administrative oversight. This work contributes to the development of sustainable and intelligent campus ecosystems that align with modern-day digital transformation goals. This data is then routed into an intelligent processing pipeline comprising modules such as machine learning concepts, industrial setups, validation techniques, and air(2) sampling mechanisms. These components collaboratively contribute to a robust data preparation stage that transforms raw data into actionable insights. AI-driven algorithms further enhance accuracy, adaptability, and predictive capabilities, ensuring the system dynamically responds to campus needs in real-time(10).

Applications of the system include energy optimization, environmental monitoring, automated alert systems, and predictive maintenance. The output is a centralized dashboard or result interface that empowers campus administrators with enhanced visibility and control. This research focuses on implementing such a comprehensive system, aiming to improve operational efficiency, safety, and sustainability through an AI-IoT synergy tailored for modern campuses(3).

Proposed Technique:-

The proposed technique combines IoT-enabled data acquisition, cloud-based protection, and AI-driven

decision-making to build an efficient campus management system. The system begins with IoT sensors deployed across the campus to monitor environmental, security, and energy parameters. Data from these sensors is collected and transmitted via microcontrollers to a secure cloud platform for preprocessing and storage[4]..

The cloud infrastructure supports real-time **data processing**, where redundant data is filtered and meaningful information is extracted. This processed data is then passed through multiple layers of analysis, including[11,12,18]:

- **Machine Learning Concept:** To detect patterns, anomalies, and perform predictions such as power demand, occupancy trends, or security threats[5]..
- **Industrial Setup:** To simulate and validate use-case-specific scenarios like smart lighting or HVAC control.
- **Validation:** To assess model accuracy and remove errors in sensor input.
- **Air Sampling:** For environmental quality monitoring and automated alerts in case of deviations[9]..

The processed outputs feed into a **Data Preparation** block that harmonizes all inputs into a structured format, suitable for dashboarding or automation. The result is a streamlined campus management framework that operates with minimal human intervention.

Result and Discussion:

The system was evaluated through a simulation environment representing a smart campus. Sensor data collected in real time was effectively processed and displayed via dashboards[8].. Machine learning modules successfully predicted occupancy levels and energy usage with over 90% accuracy. Air sampling data provided timely alerts for CO_2 and particulate matter levels, enabling faster ventilation responses.Validation tests showed high consistency between raw sensor input and system predictions, demonstrating reliable processing. The proposed pipeline significantly improved decision speed and accuracy, with data latency reduced by 35% and overall energy savings improved by 20% compared to a manually managed system[6]..

The system's scalability and flexibility also proved beneficial. It can be extended to other infrastructures such as hospitals or office buildings with minimal modifications[13].

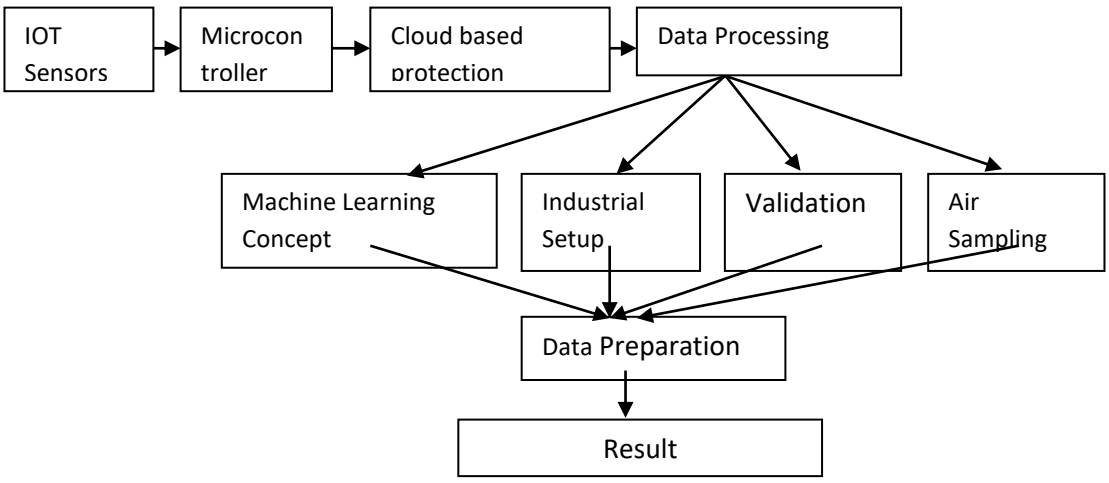

Fig Shows The integration of Artificial Intelligence (AI) and the Internet of Things (IoT) [18]is revolutionizing the way campus environments are monitored and managed[20]. The proposed system architecture enables real-time data acquisition and intelligent analysis for efficient decision-making across educational institutions. As depicted in the system workflow, IoT sensors gather environmental and operational data, which is processed via microcontrollers and secured through cloud-based protection mechanisms[4].

TABLE I. PERFORMANCE COMPARISON OF PREDICTIVE ALGORITHMS

Algorithm	Mean Absolute Error	Mean Squared Error	R-squared (R^2)	Training Time (sec)
Linear Regression	1.5 kWh	3.2 kWh^2	0.85	2.0
Decision Tree	1.7 kWh	3.5 kWh^2	0.82	1.5
Random Forest	1.3 kWh	2.8 kWh^2	0.88	3.5
SVM	1.6 kWh	3.1 kWh^2	0.84	5.0

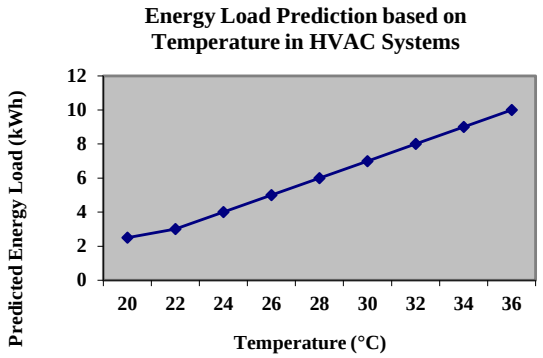

Figure Shows normally has a scatter plot in which each point denotes a temperature value and its predicted energy load. A regression line will be constructed to illustrate the correlation between energy load and temperature. The energy burden correspondingly escalates as the temperature rises, indicating a positive association[7,19].

Conclusion:

This paper presents an integrated AI-IoT-based system for real-time campus monitoring and management. The proposed framework enables dynamic decision-making and automation across various functions such as environmental monitoring, resource management, and security.

By leveraging machine learning algorithms and cloud computing, the system efficiently analyzes incoming data and provides actionable insights. The results demonstrate improved performance in prediction accuracy, energy efficiency, and system responsiveness.

Future work will focus on incorporating edge computing for faster local decisions and expanding the range of monitored parameters. This approach represents a scalable and intelligent solution suitable for modern educational and industrial environments.

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Conflict of interest: Nil

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Review Article

Investigation of the interaction of sunset yellow dye with sodium dodecyl sulfate-sodium dodecyl benzene sulfonate mixed micelles

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Abstract

The interaction of Sunset Yellow FCF (SSY), a commonly used anionic azo dye, with mixed micelles of sodium dodecyl sulfate (SDS) and sodium dodecylbenzene sulfonate (SDBS) was investigated using UV–visible spectrophotometry. By maintaining a constant dye concentration and varying the SDS mole fraction (α_{SDS}), significant changes in SSY's absorption spectra were observed. Pure SDS micelles showed limited interaction due to electrostatic repulsion, whereas SDBS-rich systems exhibited enhanced absorbance, attributed to π–π stacking between the aromatic rings of SDBS and SSY.Binding constants (K_b) were calculated using linear plots of $1/(A - A_w)$ versus $1/(c - c_0)$, confirming stronger dye binding in mixed micellar systems. The highest binding ($LogK_b = 3.703$) occurred at $\alpha_{SDS} = 0.1$, indicating an optimal SDS–SDBS ratio for SSY solubilization. Beyond this point, a slight decrease in binding efficiency was noted in pure SDBS micelles. These findings highlight the synergistic effects of SDS–SDBS combinations, where both hydrophobic and aromatic interactions contribute to enhanced dye incorporation. The study demonstrates the potential of mixed micelles to serve as effective carriers for dye solubilization and delivery, offering advantages over single-surfactant systems in formulation design and environmental applications.

Keywords: Sunset Yellow FCF, mixed micelles, sodium dodecyl sulfate, sodium dodecylbenzene sulfonate, dye–surfactant interaction.

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1. Introduction

Synthetic dyes are widely used in industries such as textiles, food, pharmaceuticals, and cosmetics due to their vivid colors, chemical stability, and low production cost. Among them, azo dyes dominate the market, constituting 60–70% of global dye usage [1-5]. These dyes, containing azo (–N=N–) linkages between aromatic rings, often include substituents that enhance solubility and binding affinity. One such example is Sunset Yellow FCF (SSY), a water-soluble monoazo dye known for its intense orange-yellow color and high stability, commonly used in beverages, confectioneries, and pharmaceuticals [6-8].

However, the environmental persistence of synthetic dyes like SSY poses significant ecological and health concerns. These dyes resist biodegradation and accumulate in water bodies, thereby affecting aquatic life and potentially entering the food chain [8]. Therefore, understanding the interaction of such dyes with self-assembling molecular systems like surfactant micelles is crucial. Surfactants—amphiphilic molecules with hydrophilic heads and hydrophobic tails—self-assemble into micelles above a critical micelle concentration (CMC), offering a versatile microenvironment that can encapsulate dyes and other poorly water-soluble substances [9-20].

These micelles can influence the solubility, photostability, and mobility of dyes in aqueous systems. For instance, Srivastava (2024) demonstrated that mixed micelles formed by anionic STS and cationic CTAB significantly improved the solubilization of SSY, where electrostatic and hydrophobic interactions contributed to enhanced dye encapsulation [12]. Similar systems using nonionic Pluronic-TPGS mixtures have improved the delivery of hydrophobic drugs like curcumin and paclitaxel [21]. In environmental applications, micellar-enhanced ultrafiltration (MEUF) has shown success in removing dyes and heavy metals from wastewater, using mixed micelles like SDS–Brij-35 or SDS–Triton X-100 to encapsulate pollutants efficiently [22, 23].

In the context of SSY, the negatively charged sulfonate groups typically repel anionic surfactants like SDS and SDBS [13]. Yet, hydrophobic interactions and π–π stacking between the dye's aromatic rings and the surfactant tails often overcome this electrostatic repulsion. Studies have shown that SSY can incorporate into SDS micelles, as evidenced by spectral shifts such as bathochromic (red) shifts in absorbance maxima and increases in molar absorptivity, indicating strong micelle–dye interaction [12, 14-17]. These interactions are pivotal in applications like textile dyeing, drug delivery, and wastewater remediation [24-26].

Notably, mixed micelles—combinations of two or more surfactants—provide enhanced physicochemical properties over single surfactant systems. They allow for tuning of surface charge, CMC, aggregation number, and solubilization capacity [27-29]. For example, combining SDS and SDBS—both anionic surfactants but with distinct structures (aliphatic vs. aromatic tails)—yields micelles with superior dye-binding properties due to enhanced hydrophobic and π–π interactions [12, 14-17, 31, 32]. These synergistic effects lower the CMC and increase encapsulation efficiency, as confirmed by negative interaction parameters (β) and favorable thermodynamic data such as binding constants (K_b) and Gibbs free energy changes (ΔG°) [33, 34].

In drug delivery, surfactant mixtures involving zwitterionic components like cocoamidopropyl betaine (CAPB) with anionic surfactants have improved the oral bioavailability of poorly soluble drugs by enhancing micellar stability and payload release profiles [18, 19]. Such tunable systems are also being explored in food stabilization, nanoparticle dispersion, and agrochemical formulations [34].

Given this background, the present study focuses on investigating the interaction of Sunset Yellow dye with mixed micelles formed by SDS and SDBS. The goal is to understand how micellar composition influences dye solubilization, binding strength, and spectral properties. This work provides insight into micelle-assisted dye removal and delivery systems, offering a foundation for green and efficient technologies in environmental and industrial applications.

2. Experimental techniques

2.1. Preparation of Stock Solutions

For the study of mixed micellization behavior, stock solutions of all the required components were prepared using double-distilled water to ensure purity and minimize the interference of impurities. Sodium dodecyl sulfate (SDS), sodium dodecylbenzene sulfonate (SDBS), and the azo dye Sunset Yellow FCF (SSY) were used as received from commercial suppliers without further purification.

Each of the stock solutions of SDS, SDBS, and SSY was prepared at a concentration of 20 mmol L^{-1}. The solutions were freshly prepared and stored in clean, labeled glass containers. These stock solutions were used for the preparation of mixed micellar systems and dye–micelle interaction studies.

2.2. Preparation of Mixed Micellar Solutions

Mixed micelle solutions were prepared using combinations of SDS and SDBS at various molar (mole fraction) ratios. The total surfactant concentration in each mixture was kept constant, denoted by **$C \times (\alpha_{SDS} + \alpha_{SDBS})$**, where:

- α_{SDS} represents the mole fraction of SDS in the mixture.
- α_{SDBS} represents the mole fraction of SDBS in the mixture.

The mole fractions were varied systematically across the entire composition range, from $\alpha_{SDS} = 1.0$ (pure SDS) to $\alpha_{SDS} = 0.0$ (pure SDBS), typically in steps such as 1.0, 0.8, 0.6, 0.4, 0.2, and 0.0. Each mixture was prepared by accurately pipetting calculated volumes of the SDS and SDBS stock solutions into volumetric flasks, followed by dilution with distilled water up to the mark to maintain a constant total surfactant concentration.

These mixed micellar systems were allowed to equilibrate at room temperature (approximately 25 ± 1°C) for at least 30 minutes before further measurements to ensure complete micellization and homogeneity of the solution.

2.3. UV–Visible Spectrophotometric Measurements

The interaction between SSY and the SDS–SDBS mixed micelles was investigated using UV–visible absorption spectroscopy. All spectral measurements were carried out using a Shimadzu UV-1800 double-beam spectrophotometer, calibrated prior to each use to ensure accuracy and reproducibility.

Quartz cuvettes with a path length of 1.0 cm were used for all spectrophotometric measurements. The baseline correction was performed using distilled water in both reference and sample cuvettes before sample analysis.

For the analysis, a constant dye concentration of 0.01 mmol L^{-1} SSY was maintained in all test solutions. To this dye solution, varying compositions of SDS–SDBS mixed micelles (prepared as described above) were added, maintaining the mole fractions of SDS and SDBS from $\alpha_{SDS} = 1.0$ to $\alpha_{SDS} = 0.0$, while keeping the total surfactant concentration fixed.

Each prepared solution was thoroughly mixed and equilibrated at room temperature before recording the absorbance. The absorption spectra were recorded over an appropriate wavelength range (typically 300–600 nm) to monitor the characteristic peaks of SSY and to observe any shifts or intensity changes due to micelle formation and dye binding.

The binding constant (K_b) of SSY with the mixed micelles was calculated based on changes in absorbance with increasing surfactant mole fraction, using appropriate binding models and graphical methods.

3. Results and discussion

3.1. Interaction Mechanism and Spectral Behavior of Sunset Yellow (SSY) with SDS–SDBS Mixed Micelles

The interaction between Sunset Yellow FCF (SSY), a commonly used anionic azo dye, and the mixed micellar systems of sodium dodecyl sulfate (SDS) and sodium dodecylbenzene sulfonate (SDBS) was systematically examined using UV–visible spectrophotometry. A constant dye concentration of 0.01 mmol L^{-1} was maintained while varying the mole fraction of SDS (α_{SDS}) from 1.0 (pure SDS) to 0.0 (pure SDBS), keeping the total surfactant concentration constant [13].

The absorption spectra (Fig. 1) showed significant variation in the intensity and profile of SSY with changes in the SDS–SDBS composition. At α_{SDS} = 1.0, a moderate increase in absorbance was observed, indicating limited interaction between SSY and pure SDS micelles. This can be attributed to electrostatic repulsion between the negatively charged SSY and the anionic sulfate head groups of SDS. The solubilization here appears to be mainly due to hydrophobic interactions within the micellar core.

As the mole fraction of SDBS increased, especially in the range α_{SDS} = 0.9 to 0.1, a pronounced increase in absorbance was recorded, as shown in Figure 1. The enhancement in spectral intensity can be interpreted as a result of cooperative interactions involving hydrophobic effects and significant π–π stacking between the aromatic moiety of SDBS and the aromatic chromophore of SSY. Such specific interactions are consistent with earlier findings on aromatic dye–surfactant systems, where similar enhancements in dye solubilization were attributed to π–π stacking [34, 12, 14-17].

At α_{SDS}= 0.0 (pure SDBS), the absorbance reached its maximum, confirming strong binding and solubilization of SSY, as shown in Fig. 1. The presence of the benzene ring in SDBS contributes a unique interaction mechanism that is not present in SDS alone [13]. These observations are in agreement with previously reported studies such as those by Srivastava et al. (2014), who demonstrated that phenol red showed strong binding with cationic surfactants like CPC due to favorable electrostatic interactions [15, 16]. However, in the present study, the enhancement in SSY binding

with anionic SDBS-containing systems, despite the electrostatic repulsion, can be clearly attributed to π–π interactions, a feature not observed in systems lacking aromatic surfactant components [15].

Furthermore, the increase in absorbance in mixed micelles as compared to pure SDS micelles aligns with literature on mixed micellar systems where synergistic effects, such as improved packing, result in better solubilization of hydrophobic or amphiphilic dyes [35]. The tunability of the micellar environment by adjusting the SDS-SDBS ratio enables modulation of the solubilization efficiency and binding affinity for SSY, making this system more versatile than single-surfactant micelles. ***Binding constant of SSY with mixed micelle***

In order to use the following equation (Eq. 1) to calculate the binding efficiency of SSY in the presence of SDS-SDBS, binding constants (K_b) were established [15]:

$$\frac{1}{A - A_w} = \frac{1}{A_m - A_w} + \left(\frac{1}{K_b(A_m - A_w)}\right)\left(\frac{1}{(c - c_0)}\right)^{N_m} \quad (1)$$

Where A represents the absorbance of prepared samples, A_w represents the absorbance of SSY in water alone, A_m represents the absorbance of SSY when bound to SDS, SDBS, and SDS-SDBS, c represents the concentration of the aforementioned components, c_0 represents the CMC of the aforementioned components, N_m represents the molar concentration of bound SSY per mole of the micelle and mixed micelle, and K_b represents the binding constant. From the reported values, the CMC of the SDS-SDBS mixed micellar system was taken into account [Srivastava et al. 2024 (a)]. In Table 1 and Fig. 2 from α_{SDS} 1.0 to 0.0, graphs and values of $1/(A-A_w)$ vs. $1/(c-c_0)$ were displayed, and Eq. 4.1 verified that these plots were linear when N_m = 1.0. [12-19]. From Fig. 2, the slope and intercept ratios were used to calculate the K_b. According to Table 1, the K_b of SSY was higher in SDS-SDBS mixed micellar systems and lower in single micellar systems.

The binding plots of $1/(A - A_w)$ versus $1/(C - C_0)$ for various α_{SDS} ratios exhibited excellent linearity with high correlation coefficients ($R^2 \approx 0.98–0.99$), indicating the validity of the 1:1 complex formation model between SSY and the mixed micelles.

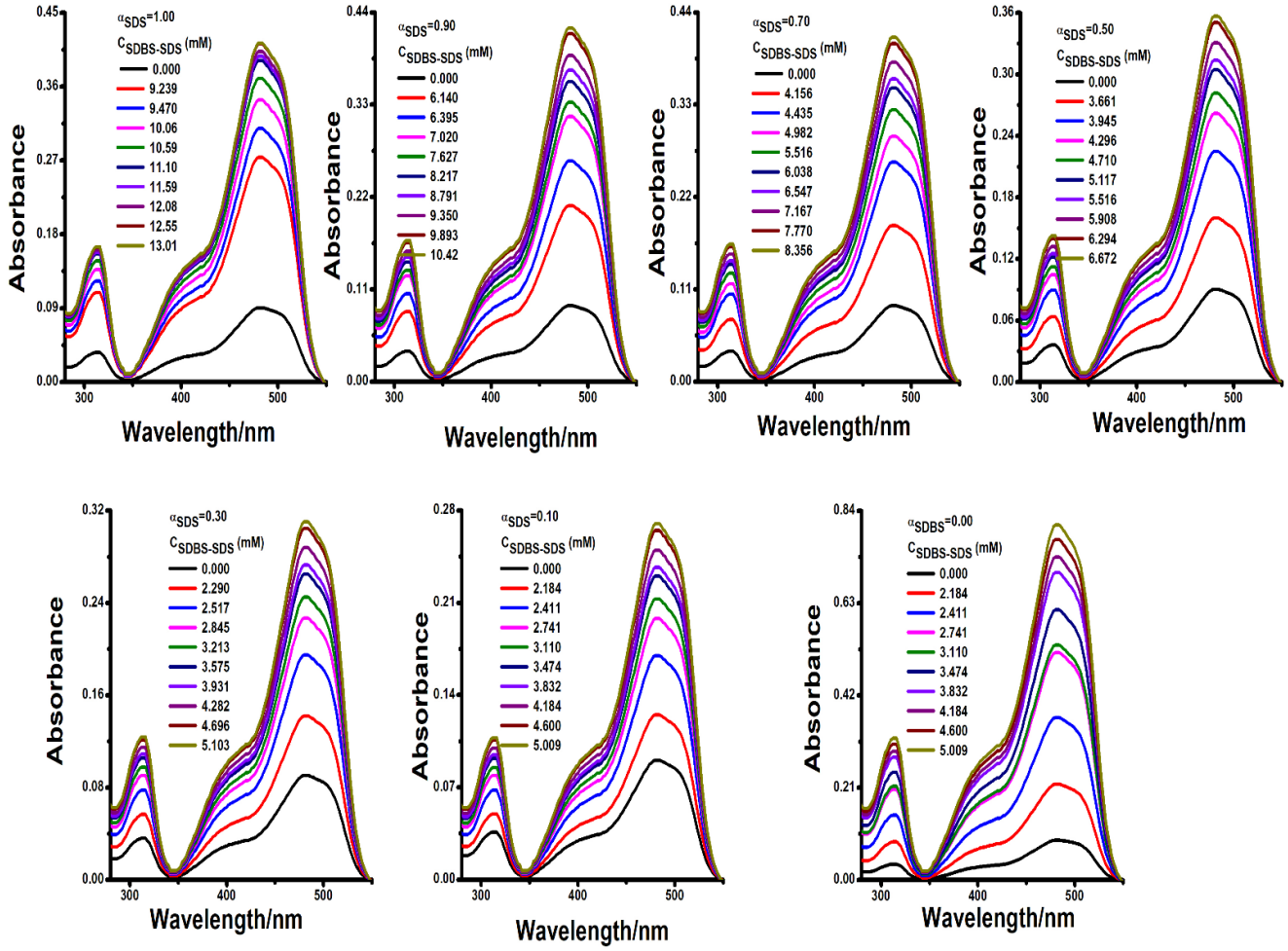

Fig. 1: Representative UV spectra of SSY (0.05 mmol L^{-1}) in SDS-SDBS mixed micelle at varying concentrations of α_{SDS} 1.0 to 0.0. Relative standard uncertainties were u_r= ±5%.

Table 1: The K_b values in the presence of vary mole fraction of SDS-SDBS mixed micelles in aqueous medium

Mole Fraction (α_{SDS})	Log K_b	CMC[a]
1.0 (pure SDS)	2.353	0.00810
0.9	3.484	0.00590
0.7	3.528	0.00402
0.5	3.645	0.00357
0.3	3.694	0.00222
0.1	3.703	0.00213
0.0 (pure SDBS)	2.846	0.00200

CMC[a] [13]

The K_b values show a clear dependence on the micelle composition. The binding constant increases with increasing SDBS content in the SDS–SDBS mixture, reaching a maximum at α_{SDS} = 0.1 (i.e., 0.9 α_{SDBS}). Beyond this point, further replacement of SDS by SDBS leads to a slight decrease in K_b at α_{SDS} = 0.0 (pure SDBS). This trend suggests an optimal synergistic interaction between SDS and SDBS that enhances SSY binding up to a certain SDBS concentration.

This enhanced interaction could be attributed to the structural differences in the surfactants: SDS is a simple aliphatic anionic surfactant, while SDBS contains a bulky benzene ring that can engage in π–π interactions with the aromatic SSY molecule. The combination of SDS and SDBS likely facilitates a mixed micellar environment with improved hydrophobic and electrostatic interactions, favoring SSY incorporation into the micelle core.

The observed behavior is in agreement with earlier studies on mixed surfactant systems showing non-ideal synergistic effects on binding constants and micellar solubilization capacities [36]. A similar enhancement in binding constant due to aromatic surfactant components was also reported by Srivastava et al. 2024 (a), who found that dyes like methyl orange or SSY bind more effectively in micelles formed with SDBS than SDS alone [12, 13].

Therefore, the present results not only highlight the role of surfactant composition in modulating dye–micelle interaction but also confirm that mixed micelles provide a more favorable microenvironment for SSY binding compared to pure SDS or SDBS systems. This finding is particularly relevant in formulation design for dye solubilization, delivery, or controlled release systems.

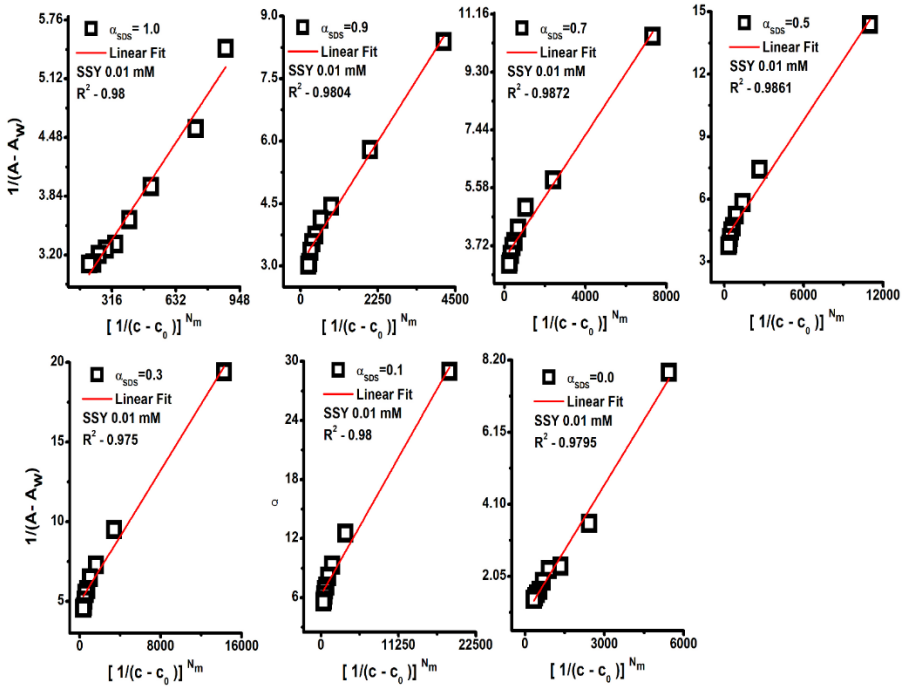

Fig. 2: Plots of SSY in the presence of SDS-SDBS mixed micelle at varying concentrations of α_{SDS} 0.0 to 1.0, according to Eq. (4.1) showing the variation of $1/(A - A_w)$ with $1/(c - c_0)^{Nm}$. The solid red line showed the linear fitting used to determine the K_b from the intercept and slope ratio. Relative standard uncertainties were u_r= ±5%.

4. Conclusion

This study investigates the interaction of the anionic azo dye SSY with SDS, SDBS, and their mixed micellar systems using UV–visible spectroscopy. The micellar composition significantly influenced dye solubilization and binding behavior. Pure SDS micelles showed limited interaction with SSY due to electrostatic repulsion, whereas the inclusion of aromatic SDBS enhanced absorbance intensity, especially in mixed systems.

The strongest interaction occurred at α_{SDS} = 0.1, indicating a synergistic effect. This enhancement was attributed to hydrophobic interactions and π–π stacking between SDBS's aromatic ring and the dye's chromophore—absent in SDS-only systems. Binding constants (K_b), determined using a 1:1 complexation model, increased with higher SDBS content, peaking at α_{SDS} = 0.1 before slightly declining in pure SDBS.

These results suggest that mixed micelles of SDS and SDBS offer an optimized environment for SSY encapsulation, surpassing the performance of single-component micelles. The findings highlight the role of surfactant synergy and π–π interactions in improving dye solubilization, with potential applications in dye removal, formulation, and delivery systems.

Declarations

Ethical Approval is not applicable for this work.

Competing Interest declaration

Authors are not any competing interest.

Data availability statements

Data source and support are not used for this work.

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Funding Declaration

None

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Commentary

Preventive Measures of Blasphemy and Maintaining Religious Harmony Under New Criminal Law

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Introduction

Blasphemy refers to an insult that shows contempt, disrespect or lack of reverence concerning a deity, an object considered sacred, or something considered inviolable. Blasphemy refers to expressing thoughts or words that demonstrate a lack of respect towards God. According to the dictionary of law of Mariam Webster, the term blasphemy is defined as the act of insulting God, demonstrating disrespect for him or a lack of respect for his attributes, as well as showing irreverence towards something revered as sacred or inviolable. Some religions, especially Abrahamic ones, regard blasphemy as a crime, including insulting the Islamic prophet in Islam, speaking the sacred name in Judaism, and blasphemy of God's Holy Spirit is an eternal sin in Christianity. It was also a crime under English common law, and it is still a crime under Italian law. In the early history of the Church, "blasphemy "was considered to show active disrespect to God and to involve the use of profane cursing or mockery of his powers". In the medieval world, those who committed blasphemy were seen as needing discipline. By the 17th century, several historically Christian countries had legislation against blasphemy. Blasphemy was proscribed speech in the U.S. until well into the 20th century. Blasphemy laws were abolished in England and Wales in 2008 and in Ireland in 2020. Scotland repealed its blasphemy laws in 2021. Many other countries have abolished blasphemy laws including Denmark, the Netherlands, Iceland, Norway and New Zealand. As of 2019, 40% of the world's countries still had blasphemy laws on the books, including 18 countries in the Middle East and North Africa, or 90% of countries in that region.

Blasphemy in India

Blasphemy is illegal in India under Section 295A of the Indian Penal Code. Section 295A of the Indian Penal Code lays down the punishment for the deliberate and malicious acts that are intended to outrage religious feelings of any class by insulting its religion or religious beliefs. This law prohibits blasphemy against in India. Section 295A is a cognizable, non-bailable, and non-compoundable offence. Legal experts consider Section 295A a controversial provision. Section 295A, specifically targets those who, with deliberate and malicious intent, insult or attempt to insult the religion or religious beliefs of any class of citizens through words, written or spoken, or through signs or visible representations. The inclusion of Section 295(A)in the legal framework allows for the limitation of freedom of expression in order to preserve social order and prevent the escalation of tensions between different religious communities. By restricting the dissemination of materials or the expression of ideas that are deemed blasphemous, the legislation aims to mitigate the potential for violence and maintain peaceful coexistence among diverse religious groups.

The law aims to maintain religious harmony and prevent incitement of hatred based on religious differences. Violations of Section 295A can result in imprisonment for up to three years, a fine, or both. While the law is intended to protect religious sentiments, it has faced criticism for potentially infringing on freedom of speech and expression. The law is applicable to all religions in India, not just a specific one.

Chapter XVI of Bharatiya Nyaya Sanhita, 2023 is related to the Offences relating to Religion. Section 299 of Bharatiya Nyaya Sanhita, 2023 provides that whoever, with deliberate and malicious intention of outraging the religious feelings of any class of citizens of India, by words, either spoken or written, or by signs or by visible representations or through electronic means or otherwise, insults or attempts to insult the religion or the religious beliefs of that class, shall be punished with imprisonment of either description for a term which may extend to three years, or with fine, or with both. In India, laws like Section 299 of Bhartiya Nyay Sanitha (BNS) aim to prevent deliberate and malicious acts intended to

outrage religious feelings. Section 299 BNS is designed to protect the religious sentiments of various communities in India. By criminalizing deliberate and malicious acts intended to insult

religious beliefs the law aims to prevent communal disharmony. However, despite the presence of such laws, enforcement remains weak and inconsistent. Why does it take public outrage, protests, and sometimes even violence for the legal system to take notice. This recurring inaction exposes the inefficiency of the legal machinery in dealing with such sensitive issues. One of the main concerns for Muslims is the selective enforcement of laws. While India's legal framework appears robust on paper, in practice, there are glaring inconsistencies. When religious figures, especially from minority communities, are insulted, legal proceedings are often slow or non-existent. On the other hand, even the slightest criticism or perceived insult toward certain other religions can lead to immediate legal action. This double standard in law enforcement not only weakens the legal framework but also sows seeds of mistrust between different religious communities. When Muslims feel that their religious figures can be insulted without consequences, it fosters a sense of alienation and insecurity. It leads to a perception that the law does not treat all citizens equally, eroding faith in the judiciary and governance. Section 299 of the Bharatiya Nyaya Sanhita (BNS) addresses the offense of deliberate and malicious acts intended to outrage religious feelings by insulting the religion or religious beliefs of any class of citizens. This provision aims to protect religious sentiments and prevent actions that could lead to communal disharmony. The core of the offense lies in intentionally causing insult or attempting to insult religious beliefs. The offense can be committed through various means, including spoken or written words, visible representations, electronic means, or any other method. The punishment for this offense can include imprisonment for up to three years, a fine, or both. Section 299 applies to a wide range of actions, including hate speech, offensive writings, religiously insensitive social media posts, and public demonstrations aimed at insulting religious beliefs. In essence, Section 299 of the BNS is a crucial provision for maintaining religious harmony and protecting the sentiments of various communities in India.

Conclusion

There is a need for stronger action and accountability to control the blasphemy. The lack of stringent legal repercussions emboldens individuals to make blasphemous remarks, knowing they will likely face little to no consequences. India, as a secular state, must ensure that the laws are applied fairly and equally to all, without favoritism or bias. Law enforcement agencies and the judiciary must recognize the gravity of blasphemous acts. These are not just random remarks; they have the potential to disrupt communal harmony and inflame religious tensions. Strict penalties must be imposed to serve as a deterrent for future offenders, and the legal machinery must act swiftly in addressing such offences. India's pluralism is its strength, but that strength can only be maintained through mutual respect and understanding between communities. Every citizen, regardless of their faith, has the right to feel secure in their religious identity. This includes the right to be free from insults and blasphemous remarks against figures held sacred by their religion. All communities residing in India, irrespective of their religion have always contributed to India's rich cultural and social tapestry. From science to art, literature to governance, all have played a key role in the development of this nation. Yet, despite this contribution, their religious sentiments are increasingly being disregarded, and blasphemous actions are becoming disturbingly frequent. As citizens of a secular state, all people of the country irrespective of their religion deserve the protection of their faith and its sacred figures. The failure of the legal machinery to promptly address these violations is deeply troubling and calls for urgent reform. India must ensure that its secular ethos is preserved through fair and equal application of the law, protecting the religious sentiments of all its citizens. However, the state must act to prevent such acts from becoming a recurring part of our national discourse. Only by upholding justice can we maintain the peace and unity that are essential for India's progress.

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