NIILM University, Kaithal, Haryana

ICSSR Sponsored

National Seminar

On

Sustainable Development and Energy Security: An Interdisciplinary Approach

Organized by

Centre for Professional Development (CPD)

&

Department of Economics

NIILM University, Kaithal, Haryana, India

July 15-16, 2025

SOUVENIR

"Sustainable Development and Energy Security: An Interdisciplinary Approach"

A Book of Seminar Proceedings

Editor(s):

Prof. (Dr.) Ravinder Pandey
Ms. Mehak Gupta

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&
Department of Economics
NIILM University, Kaithal, Haryana, India

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Bandaru Dattatraya
Governor, Haryana

बंडारू दत्तात्रेय
राज्यपाल, हरियाणा

MESSAGE

7th July, 2025

It is a matter of delight to learn that NIILM University, Kaithal, Haryana, is organizing a national seminar on 'Sustainable Development and Energy Security: An Interdisciplinary Approach' on July 15-16, 2025, which has been sponsored by ICSSR, New Delhi.

We all know well that sustainable development and energy security are the key to realizing the goal of an inclusive Viksit Bharat by 2027. As India marches toward becoming a developed nation, it must ensure that economic growth does not come at the cost of environmental degradation or social inequity.

Sustainable development offers a balanced approach, integrating ecological responsibility, economic progress, and social welfare, thereby uplifting all sections of society, especially the marginalized. Simultaneously, robust energy security, driven by a diversified and renewable energy mix, is essential to power industries, agriculture, and services across both urban and rural areas.

Ensuring affordable, reliable, and clean energy access for every citizen will not only drive productivity and innovation but also support climate resilience. Together, these pillars form the foundation of an inclusive, self-reliant, and future-ready Bharat.

I am sure that the seminar promises to provide a valuable platform for scholars, policymakers, and industry experts to engage in meaningful dialogue on one of the most pressing global challenges.

Congratulations and best wishes!

(Bandaru Dattatraya)

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Message

Prof. (Dr.) Shamim Ahmed
Vice Chancellor
NIILM University, Kaithal, India

It is with immense pleasure that I extend a warm welcome to all delegates, scholars, and participants of the ICSSR-sponsored National Seminar on "Sustainable Development and Energy Security: An Interdisciplinary Approach." This significant event, hosted by NIILM University, Kaithal, Haryana, on July 15th and 16th, 2025, marks a crucial moment for intellectual discourse on two of the most pressing challenges facing humanity today.

In an era defined by rapid environmental shifts and growing energy demands, the themes of sustainable development and energy security have transcended disciplinary boundaries to become truly global concerns. This seminar provides a vital platform for bringing together diverse perspectives from various fields—be it economics, environmental science, technology, social sciences, or policy-making—to foster a holistic understanding and explore innovative solutions.

Our collective future hinges on our ability to strike a delicate balance between progress and preservation. Energy security, a cornerstone of national development, must be pursued in tandem with sustainable practices that safeguard our planet for generations to come. This interdisciplinary approach is not merely a theoretical construct; it is a practical necessity for crafting effective and equitable pathways forward.

I am confident that the deliberations over these two days will be highly insightful, leading to fruitful discussions, groundbreaking ideas, and collaborative initiatives. The intellectual vibrancy and diverse expertise present in this gathering will undoubtedly contribute significantly to the ongoing global dialogue on these critical issues.

I wish all participants a rewarding and enriching experience. Let us engage, innovate, and inspire each other to build a more sustainable and energy-secure world.

Prof. (Dr.) Shamim Ahmed

Message

Prof. (Dr.) Rajiv Dahiya
Registrar
NIILM University, Kaithal, India

We are thrilled to welcome you to the conference on "Sustainable Development and Energy Security: An Interdisciplinary Approach"—a dynamic forum that brings together scholars, researchers, policymakers, and industry leaders to engage in vital dialogue on one of the defining challenges of our era.

In a world grappling with the twin imperatives of environmental sustainability and energy resilience, this conference seeks to inspire cross-disciplinary collaboration—bridging engineering, environmental science, economics, policy, and social innovation. Our shared mission is to explore holistic strategies that advance sustainable development while ensuring reliable, equitable access to energy.

Over the course of this event, keynote addresses, panel discussions, and research presentations will delve into urgent topics including renewable energy transitions, climate change mitigation, energy policy, green technologies, and sustainable urban planning.

Together, let us imagine and shape a future where development is sustainable, energy is secure, and solutions are driven by a rich diversity of perspectives and expertise

Prof. (Dr.) Rajiv Dahiya

Message

Prof. (Dr.) Sandeep Kumar
Director
Centre for Professional Development (CPD)
NIILM University, Kaithal, Haryana

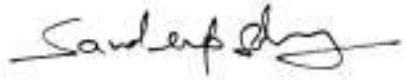
It is with immense pleasure and a deep sense of purpose that I welcome you to the ICSSR-sponsored National Seminar on "Sustainable Development and Energy Security: An Interdisciplinary Approach." As the Director of the Centre for Professional Development (CPD) at NIILM University, I am particularly proud to see such a crucial and timely topic being addressed with an interdisciplinary lens.

The challenges of sustainable development and energy security are no longer confined to isolated academic disciplines. They demand a comprehensive, collaborative approach that transcends traditional boundaries. Our seminar aims to foster this exact spirit, bringing together experts and thought leaders from diverse fields to share their insights, research, and innovative solutions. This cross-pollination of ideas is essential for developing robust and practical strategies that can truly make a difference.

At CPD, our mission is to equip individuals with the knowledge and skills necessary to navigate complex global challenges. This seminar perfectly aligns with that mission, offering an invaluable opportunity for professional growth, intellectual exchange, and networking. I am confident that the discussions over the next two days will be rich, stimulating, and will contribute significantly to advancing our collective understanding of these vital issues.

I extend my sincere gratitude to the ICSSR for their generous sponsorship, which has made this seminar possible. I also thank the organizing committee for their tireless efforts in putting together such a compelling program.

I encourage all participants to actively engage, question, and collaborate. Your contributions are vital to the success of this seminar and, more importantly, to shaping a sustainable and energy-secure future.



Prof. (Dr.) Sandeep Kumar

Message

Prof. (Dr.) Ravinder Pandey
Convenor
NIILM University, Kaithal, India

It gives me immense pleasure to welcome all participants, researchers, academicians, policymakers, and industry professionals to this ICSSR-sponsored National Seminar on *"Sustainable Development and Energy Security: An Interdisciplinary Approach."* This event, held under the auspices of NIILM University, Kaithal, represents a significant platform for the exchange of ideas, collaborative learning, and forward-looking discussions on the pressing global challenges of our time.

The themes of sustainability and energy security are intricately linked, demanding a convergence of disciplines and collaborative strategies to chart a course toward a resilient and inclusive future. As the world grapples with climate change, resource depletion, and energy inequities, our collective role as educators, thinkers, and innovators becomes increasingly critical.

This seminar brings together voices from diverse fields—economics, environmental science, engineering, public policy, and social sciences—to foster holistic understanding and actionable solutions. I am confident that the deliberations held over these two days will not only enrich our perspectives but also contribute meaningfully to the national and global discourse on sustainable development.

I extend my heartfelt gratitude to the Indian Council of Social Science Research (ICSSR) for their generous support, to our distinguished speakers and contributors for sharing their expertise, and to all the participants for their enthusiastic engagement.

Prof. (Dr.) Ravinder Pandey

Message

Dr. Mahender Singh
Co-Convener
NIILM University, Kaithal, India

It is with great pride and a deep sense of responsibility that I extend my warm greetings to all participants of this ICSSR-sponsored National Seminar on *"Sustainable Development and Energy Security: An Interdisciplinary Approach."* Organized by NIILM University, this seminar seeks to explore the complex interrelation between sustainable growth and energy needs—an area of vital importance in today's rapidly transforming global landscape.

Sustainable development is not merely a goal, but a continuous process that requires innovation, inclusive policymaking, and responsible resource management. Similarly, achieving energy security is pivotal to ensuring socio-economic stability and environmental integrity. The interdisciplinary approach adopted by this seminar emphasizes the importance of collaboration across academic domains to arrive at integrated and impactful solutions.

As Co-Convenor, I am honored to be part of this significant academic initiative. I would like to express my sincere thanks to the Indian Council of Social Science Research (ICSSR) for their support, to our Convenor Dr. Ravinder Pandey for his leadership, and to the entire organizing team whose efforts have made this seminar possible.

I hope that the insights and discussions emerging from this event will contribute to meaningful research, informed policymaking, and a collective commitment to a sustainable and secure future.

With best wishes for a successful and enriching seminar experience.

Mahender Singh

Dr. Mahender Singh

Message

Dr. Manoj Kumar
Co-Convener
NIILM University, Kaithal, India

It is an honor and privilege to serve as Co-Convenor of this ICSSR-sponsored National Seminar on *"Sustainable Development and Energy Security: An Interdisciplinary Approach"* hosted by NIILM University, Kaithal. This seminar brings together a diverse group of scholars, researchers, professionals, and policymakers to deliberate on two of the most urgent and interconnected challenges of our time: sustainability and energy security.

The theme of this seminar reflects the need for interdisciplinary collaboration in addressing complex global issues. In the face of climate change, rising energy demands, and environmental degradation, it is imperative to adopt innovative and inclusive strategies that balance development with ecological responsibility.

This seminar provides a valuable platform for exchanging knowledge, sharing research findings, and building partnerships that can contribute to more sustainable and secure futures. I am confident that the insights gained here will inspire new directions in research, education, and policy formulation.

I extend my heartfelt thanks to the Indian Council of Social Science Research (ICSSR) for supporting this academic endeavor. I also express my appreciation to Convenor Dr. Ravinder Pandey, my fellow Co-Convenors, the organizing team, and all participants for their commitment and contribution to making this seminar a success.
Wishing all attendees a fruitful and engaging seminar experience.

Dr. Manoj Kumar

ACKNOWLEDGEMENT

NIILM University, Kaithal extends its heartfelt gratitude to all the distinguished participants, esteemed speakers, scholars, researchers, and attendees who played a vital role in the success of the **National Seminar** on **"Sustainable Development and Energy Security: An Interdisciplinary Approach"**, held on **July 15-16, 2025**.

We are deeply honored by the presence of our respected guests and keynote speakers, whose enlightening insights and scholarly contributions enriched the discourse and broadened our understanding of the critical nexus between sustainable development and energy security.

A special note of appreciation goes to our organizing committee, faculty members, and staff, whose unwavering commitment, detailed planning, and tireless efforts ensured the smooth and impactful execution of the seminar.

We also acknowledge the invaluable support of the NIILM University community, our sponsors, media partners, and all collaborators who contributed in various capacities to the success of this academic gathering. Your collective efforts and enthusiastic participation have significantly fostered interdisciplinary dialogue and advanced national conversations on sustainable and secure energy futures.

Thank you once again for your meaningful contributions and dedication to academic excellence. We look forward to your continued engagement in our future initiatives aimed at fostering knowledge, innovation, and sustainable development.

ABOUT THE SEMINAR

Centre for Professional Development & Department of Economics, NIILM University, Kaithal, Haryana, is organizing Two DaysICSSR Sponsored National Seminar on "Sustainable Development and Energy Security: An Interdisciplinary Approach" on July 15-16, 2025.

About the Seminar:

Sustainable development and energy security are two of the greatest global challenges of our time. As the world grapples with rising energy demands, climate change, dwindling fossil fuel reserves, and geopolitical instability, there is a growing need for innovative and sustainable solutions that balance environmental, economic, and social goals.This seminar on "Sustainable Development and Energy Security" aims to understand the complex relationship between sustainable development and the long-term availability of energy resources. Adopting an interdisciplinary approach, the program will draw insights from environmental science, engineering, economics, and public policy to explore how collaborative efforts can effectively address these challenges.Sustainable development, as outlined by the United Nations, emphasizes on meeting the needs of the present without compromising the future. Similarly, energy security focuses on the uninterrupted supply of affordable energy. Achieving these objectives together requires a strategic shift from conventional fossil fuel-based systems towards clean and renewable energy sources such as solar, wind, hydro, and bio-energy.

Sub Themes of the Seminar:

The research papers to be presented during the conference will revolve around the following clusters:

Cluster 1: Economic Perspectives on Energy Security and Sustainability

Cluster 2: Political and Administrative Strategies for Energy Sustainability

Cluster 3: Legal and International Policy Dimensions

Cluster 4: National Security and Strategic Studies

Cluster 5: Environmental and Technological Aspects of Renewable Energy

Cluster 6: Social and Cultural Dimensions of Energy Transition

Sub-themes are not limited to the ones mentioned above; any relevant research on the main theme will be considered for presentation.

Seminar Schedule

Date: July 15-16, 2025

Venue:NIILM University, Kaithal, Haryana

Last date of registration: July 05, 2025

Last date of abstract/ full paper submission: July 10, 2025

Call for Research Papers: Well-researched papers from multiple disciplines are invited from academicians, research scholars, students, and professionals from different institutions for presentation at the conference.

A proceeding book of the conference including all abstracts (all presenters) with ISBN, papers presented during the conference, and full papers as per choice to publish with ISBN, soft copy will be provided to all research presenters.

Paper Publication:

Authors who will present their research papers at the seminar will be eligible to send their research paper (same as presented) for publication in the NIILM University International Multidisciplinary Journals, peer-reviewed academic/ scholarly, open-access journals with DOI

Submission Guidelines: For publication

- Full-length papers should not exceed 6000 words don't add endnotes or footnotes.
- For English Full paper: It should be typed in Microsoft Word. The font should be "Times New Roman" with "12" sizes for matter,16 sizes in bold for title, 14 sizes in bold for main headings & 12 sizes in bold for sub-headings, having a line spacing of 1.5 inches and a one-inch custom margin on all sides & A4 Size Paper.
- For Hindi Full paper: It should be typed in Microsoft Word in "Unicode" with font size 14 for content, 16 bold for the title & 14 bold for headings, having line spacing of 1.5 inches and a one-inch custom margin on all sides.
- A Uniform Style for Citation should be strictly adhered to while submitting full-length papers.
- All in-text citations must be hyperlinked with the references (cross-reference). Use the word reference tab for cross-referencing and hyperlinking. We also recommend you use Mendeley or other referencing tools.
- Submit a brief profile of the author on the Word file/ doc file, which should not exceed more than one page, and try to keep it as brief as possible.
- Each article must be submitted with an impact statement of not more than 150 words.

- References/ bibliography must be serialized as 1, 2, ...
- Provide your ORCID, and include your ORCID in your article just below your name.
- Must check grammar under the review tab of MS Word.

Full-length papers shall be emailed toseminar@niilmuniversity.ac.in

Seminar Fee

Participation Fee: Rs. 500

Participation & Presentation Fee: Rs. 1000 (Rs. 500 for each coauthor, co-author need not register separately, mention the detail of the co-author in the registration form)

SOP:

Step 1: Submit the fee

Step 2: Register online at the given link: https://forms.gle/1nzqtGWdfRQzJLhZ7

Step 3: Send abstract/ full paper to seminar@niilmuniversity.ac.in

Step 4: You will get an acceptance in reply to the email

Fee Submission Details:

Account Holder Name- NIILM University

Account No- 50100159479920

IFSC Code- HDFC0003231

Bank Branch Address- HDFC Bank Village Keorak, Kaithal Haryana

Delegates will get the seminar schedule by July 12, 2025

Conference Contact and Helpline

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About the University

Established in 2011, NIILM University is dedicated to providing quality, skill-focused education, primarily to students in the rural heartland of Haryana. Notably, the university boasts North India's first AI Campus, further solidifying its commitment to cutting-edge education. NIILM University is committed to empowering students with 21st-century skills and values, enhancing their employability, and aligning with the goals of NEP 2020.

NIILM University fosters a dynamic and supportive learning environment, encouraging flexibility, creativity, and innovation. Students are guided to discover their potential, overcome challenges, and achieve their aspirations. The university emphasizes value-based learning, a strong student-institution relationship, and industry-relevant academic programs benchmarked against international standards. With a focus on individual attention and a vibrant faculty comprising both academic and industry experts, NIILM University prepares students to excel in a competitive world.

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NIILM University, Kaithal, Haryana

ICSSR Sponsored National Seminar July 15-16, 2025

"Sustainable Development and Energy Security: An Interdisciplinary Approach"

Day 1: Tuesday, July 15, 2025

Seminar Schedule

09:00 am to 10:30 am	Registration
Inaugural& Keynote Session: 10:30 am to 01:00 pm	
Convener Coordinator	Dr. Ravinder Pandey, Professor, Department of Economics, NIILM University Kaithal, Haryana Dr Mahender Singh, Associate Professor, Department of Political Science Dr Manoj, Assistant Professor, Department of Journalism & Mass Communication Dr. Renu Bala, Associate Professor, Department of Library & Information Science, NIILM University, Kaithal, Haryana
Seminar Facilitator/ Moderator	Dr. Ekta Chahal, Assistant Professor, Department of English, NIILM University, Kaithal, Haryana
Chief Guest: Seminar Chairperson:	Prof. R.C. Kuhad, former Vice Chancellor of Central University of Haryana Prof. (Dr.) Pradeep Kumar, Professor, Department of Economics, NIILM University Kaithal, Haryana
Inaugural: 10:30 am to 11:00 am **Keynote Session 11:00 am to 01:00 pm** Speakers	Welcome address by Seminar Chairperson, Prof. (Dr.) Pradeep Kumar, Professor, Department of Economics, NIILM University Kaithal, Haryana Presidential address by the Honourable Vice Chancellor, Prof. (Dr.) Shamim Ahmed, NIILM University Special/ Inaugural address by Chief Guest, Prof. R.C. Kuhad, former Vice Chancellor of Central University of Haryana Guest of Honor Address by Prof. (Dr.) Rajesh Punia, Department of Physics, Maharishi Dayanand University, Rohtak Keynote address by Prof. Anuradha Banerjee, Centre for the Study of Regional Development (CSRD), JNU, New Delhi

	Release of Souvenir **Felicitation of Guests**
	Lunch Break: 01:00 pm to 01:30
Plenary Sessions and Roundtable Discussion: 01:30 pm to 03:30 pm	
Session 1	Seminar Hall
Session Chair	Prof. Kuldeep Malik, Department of Geography, Pt Neki Ram Sharma Govt College, Rohtak
Session Coordinator	Ms. Mehak Gupta, Assistant Professor, Department of Forensic Science, NIILM University, Kaithal, Haryana
Session 2	Computer Lab, Block B
Session Chair	Dr. Rajiv Pal, Associate Professor, Department of Mathematics, NIILM University, Kaithal, Haryana
Session Coordinator	Dr.Vikrant, Assistant Professor, Department of Mechanical Engineering, NIILM University, Kaithal, Haryana
	Roundtable Discussion: Conference Hall "Balancing Energy Security Imperatives with Climate Action Goals: Navigating Trade-offs and Synergies"
Seminar Hall	**Moderator:** Dr. Richa Mor, Assistant Professor, Department of Biotechnology, NIILM University, Kaithal, Haryana, India **Session Chairperson:** Dr. Swarna, Assistant Professor, Department of English, INM PG College, Meerut **Panelists:** Ms. Parnit Tomar, Assistant Professor, Gandhi Vidya Niketan College,Ramala, UP Dr. Rahul, Head of the Department of Sociology, Gandhi Adarsh College Samalkha, Panipat. Dr. Ramesh Kait, Assistant Professor, Department of Computer Science & Applications, Kurukshetra University, Kurukshetra.
	National Anthem

NIILM University, Kaithal, Haryana

ICSSR Sponsored National Seminar July 15-16, 2025

"Sustainable Development and Energy Security: An Interdisciplinary Approach"

Day 2: Wednesday, July 16, 2025

Seminar Schedule

Inaugural& Keynote Session: 10:30 am to 01:00 pm	
Convener Coordinator	Dr. Ravinder Pandey, Professor, Department of Economics, NIILM University Kaithal, Haryana Dr Mahender Singh, Associate Professor, Department of Political Science Dr Manoj, Assistant Professor, Department of Journalism & Mass Communication Dr. Renu Bala, Associate Professor, Department of Library & Information Science, NIILM University, Kaithal, Haryana
Seminar Facilitator/ Moderator	Dr. Aradhna Sagwal, Assistant Professor, Department of Agriculture, NIILM University, Kaithal, Haryana, India
Chief Guest Seminar Chairperson	Dr. Rajesh Kumar, Director, Indian Council of Historical Research (ICHR), Govt of India, New Delhi. Prof. (Dr.) Pradeep Kumar, Professor, Department of Economics, NIILM University Kaithal, Haryana
Inaugural: 10:30 am to 11:00 am **Keynote Session 11:00 am to 1:00 pm** Speakers	Welcome address by Seminar Chairperson, Prof. (Dr.) Pradeep Kumar, Professor, Department of Economics, NIILM University Kaithal, Haryana Presidential address by the Honourable Vice Chancellor, Prof. (Dr.) Shamim Ahmed, NIILM University Special/ Inaugural address by Chief Guest Dr Rajesh Kumar, Director, Indian Council of Historical Research (ICHR), Govt of India, New Delhi. Guest of Honor Address by Prof. Virender Singh Negi, Department of Geography, S.B.S. (E) College, Sheikh Sarai Phase, New Delhi, University of Delhi

	Keynote address by Dr. Jagbir Singh, Professor, Department of Geography, Swami Shraddhanand College, Alipur, New Delhi, University of Delhi
	Felicitation of Guests
	Lunch Break: 01:00 pm to 01:30 pm
Plenary Sessions and Roundtable Discussion: 01:30 pm to 03:30 pm	
Session 1	Seminar Hall
Session Chair	Dr. Sushil Dalal, Associate Professor, Department of Geography, Pt. NRS Govt College, Rohtak
Session Coordinator	Dr. Sonu Kumar, Assistant Professor, Department of Commerce, NIILM University, Kaithal, Haryana, India
Session 2	Computer Lab, Block B
Session Chair	Dr. Suresh Kumar, Associate Professor, Department of Physics, MMDU Mullana
Session Coordinator	Dr. Sonam, Assistant Professor, Department of Sociology, NIILM University, Kaithal, Haryana, India
	Roundtable Discussion: Conference Hall "The Interplay Between Renewable Energy Transition and Resource Management for Sustainable Development"
Seminar Hall	**Moderator:** Ms. Shweta, Assistant Professor, Department of Commerce, NIILM University, Kaithal, Haryana **Session Chairperson:** Dr Kamalpreet, Associate Professor, Department of Commerce, NIILM University, Kaithal, Haryana **Panellists:** Dr. Annuradha, Assistant Professor, Department of English, MDSD College, Ambala Dr Parveen Kumar, Assistant Professor & Head,Department of History,Dyal Singh College, Karnal, Haryana Dr. Anand Pal Sr. Cartographer,Department of Geography, Swami Shraddhanand College, Alipur, New Delhi, University of Delhi Dr Renu Baliyan, Associate Professor, Department of History, KVA DAV College for Women, Karnal
National Anthem	
Certification	

List of Invited Talks

- Prof. R.C. Kuhad, former Vice Chancellor of Central University of Haryana
- Dr. Rajesh Kumar, Director, Indian Council of Historical Research (ICHR), Govt of India, New Delhi.
- Prof. Virender Singh Negi, Department of Geography, S.B.S. (E) College, Sheikh Sarai Phase, New Delhi, University of Delhi
- Dr. Jagbir Singh, Professor, Department of Geography, Swami Shraddhanand College, Alipur, New Delhi, University of Delhi
- Prof. (Dr.) Rajesh Punia, Department of Physics, Maharishi Dayanand University, Rohtak
- Prof. Anuradha Banerjee, Centre for the Study of Regional Development (CSRD), JNU, New Delhi
- Dr. Anand Pal Sr. Cartographer,Department of Geography, Swami Shraddhanand College, Alipur, New Delhi, University of Delhi
- Dr. Rahul, Head of the Department of Sociology, Gandhi Adarsh College Samalkha, Panipat
- Dr Ramesh Kait, Assistant Professor, Department of Computer Science & Applications, Kurukshetra University, Kurukshetra
- Dr. Annuradha, Assistant Professor, Department of English, MDSD College, Ambala
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- Ms. Parnit Tomar, Assistant Professor, Gandhi Vidya Niketan College,Ramala, UP

Table of Content


Abstracts

Transformation of Wooden Pallets to Plastic Pallets

Khan, Imran

Research Scholar, NIILM University Kaithal, Haryana, India

Abstract

Pallets are important segment on part of logistics movement across the world and it plays a significant role in global ecology, approximately 5 - 7 billion trees are cut for raw materials which includes contribution on producing wooden pallets This paper reviews the transformation of wooden pallets to plastic pallets with the intent of providing insights into the methodological choices made, as well as compiling the data from the studies reviewed. The study includes analysis of market challenges, cost comparison, reliability and quality which will diversify the global logistics system.

Keywords: Lumber, Logistics, Trees, Ecology system

A Study on Required 'Ruralization' For Sustainable Rural Development (SRD) Of Villages in the Region (India)

Prakash, Praveen

Department of Economics, Freedom Fighter Pandit Susheel Rattan Government Degree College, Jawalamukhi, Kangra, H.P.

Abstract

The narrowed-down conventional-idea of the Rural-Areas and narrative thereof, have to be revisited, and required to be 'Redefined'. The area with, dominatingly, agricultural land and primary-activities, along with neat surroundings and clear environment, as well as masses having simple living and limited demands, with religious-fatalistic daily-life (simpleton) has to be designated as Rural Areas; needed to be reviewed in the 21st century, the age of IoT and AI, especially in the developing-region like South-ASIAs of world, including India. This research-effort has been an empirical attempt to get and add insights into the main issues of Low-RD on account of Non-Diversification of Agriculture and Allied Activities, Low Level & Quality of Education in Villages, neglected-focus of the systems and per-capita income of farmers as well as low production – productivity. Whereas, in developed-world, population in rural-areas are very well-equipped with Artisanal-Skills (upgraded), evolved and high-quality affordable – subsidized Implements – Tools, Support – Handholding by LSGs / Federal Depts, Scaling and Anchored Production, Increased Productivity – Production, etc. In 2019, the workforce in rural non-farm activities (due to proper Diversification of Primary activities) on an average was 46%, significantly higher than rural population of 30%, in OECD Nordic Developed Member Countries. The same potential was very much available in Villages of India, if development-focus would have genuinely been given after independence to these regions. The villages have the power of creating Reverse-Migration (from Urban-to-Rural), if properly developed and managed, thereby containing the problem of Unemployment and Lowest-Development scenario in the rural-regions. The implication of this study would be change in the outlook of people at helm of affairs towards rural-areas and reallotting the much needed (though delayed) focus, and simultaneously take all available measures in the form of required policies – programs.

Keywords: Narrowed-Down, Conventional-Idea, Rural-Areas, Simpleton, Non-Diversification, Artisanal-Skills, Reverse-Migration.

Ketonic Aldehyde resin and cyclo-olefines study on making of common conductive paint for deferent polymer Subsrate

Rahate, Amar Ramesh

Research Scholar, Department of Chemistry, NIILM University Kaithal, Haryana, India

Abstract

This research investigates the formulation and performance of a common conductive paint system utilizing ketonic aldehyde resin and cyclo-olefins, targeting application across diverse polymer substrates. The study aims to address the challenge of achieving uniform electrical conductivity, strong adhesion, and consistent film formation on various plastics such as polypropylene (PP), acrylonitrile butadiene styrene (ABS), and polycarbonate (PC) and Nylone. Ketonic aldehyde resin, known for its excellent film-forming and binding characteristics, was combined with modified cyclo-olefins to optimize the resin matrix for conductivity enhancement and substrate compatibility. Conductive pigments such as carbon black and graphite were dispersed into this resin system, and various paint formulations were developed and applied to multiple plastic panels. Key performance metrics—including surface resistivity, crosshatch adhesion, flexibility, and thermal stability—were evaluated. Results demonstrate that the ketonic aldehyde–cyclo-olefin resin matrix can serve as a versatile platform for common conductive paints suitable for electrostatic applications across different polymers. This development has potential to streamline coating processes in automotive, electronics, and packaging industries by reducing the need for substrate-specific conductive coatings.

Keywords: Ketonic aldehyde resin, cyclo-olefins, conductive paint, polymer substrate, electrostatic coating, plastic adhesion, surface resistivity

Social and cultural dimensions of energy transition

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Abstract

The social and cultural dimensions of India's energy transition are multifaceted and critical for a just and sustainable shift away from fossil fuels. These dimensions include impacts on livelihoods, social equity, cultural identities, and the need for inclusive planning and participation. Understanding these aspects is crucial for navigating the challenges and maximizing the benefits of the transition. Engaging with local communities to understand their cultural values and concerns is essential for designing culturally appropriate and sustainable energy solutions. Climate change is one of the most significant threats that the world is facing today. Fossil fuels contribute substantially to greenhouse gas emissions that lead to global warming. A transition towards cleaner sources of energy production is the most logical approach, which, however, does not come without complications. As an emerging market economy, India's energy transition may be considered an opportunity to propel the nation towards a structural shift that builds the economy from the ground up. Whether through technological innovations or appropriate policy mechanisms, energy transition opens the window of an inclusive development plan that considers the needs of those who have been mainly neglected until now. Utilizing diverse methodological approaches, including qualitative and quantitative research, can provide a more comprehensive understanding of these impacts. By addressing these social and cultural dimensions, India can strive for a just, sustainable, and inclusive energy transition that benefits all its citizens.

Keywords: Social dimensions, Cultural dimensions, Climate change, Technological innovations

International Journal of Judicial Law

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Abstract

A recent systematic evaluation found that on-site medication registrations and quality inspections may reduce counterfeit and substandard drugs. Replicating successful therapy without making any changes is tough. A complete data analysis was also the aim, in addition to systematic actions to combat medicine counterfeiting. We searched fourteen databases electronically throughout our extensive examination. We analyzed data on the treatments' effectiveness, viability, reliability, financial results, and difficulties and prospects. After choosing relevant papers, two reviewers abstracted the data individually and in duplicate. A narrative synthesis was done on the findings, which were classified by intervention. The outcome nineteen of 10,220 citations were acceptable. The results include reducing pharmaceutical diversion, improving communication, providing drug quality feedback, and lobbying for strict licensing regulations to strengthen regulatory systems like registration. Onsite quality monitoring and inspection solutions may be practical and cost-effective for large drug samples undergoing preliminary testing. Implement counterfeit pharmaceutical laws, strict fines, tools to control internet medication sales, and legal and judicial education. Public awareness and education initiatives need several platforms and specialist material. Product authentication systems can detect counterfeit medications in the supply chain, but they require a sound information system design to work. To ensure pharma-covigilance systems work, underreporting must be addressed. The following paragraphs will explore the aspects that affect the design and execution of systemic medication counterfeiting prevention methods. These must be considered by policymakers to ensure their efforts are effective.

Analyzing the Interplay between Social Norms and Legal Frameworks in Addressing Violence against Women in India

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Abstract

Violence against women remains a pervasive problem in India, rooted deeply in cultural, social, and institutional frameworks. This review explores how entrenched social norms intersect with legal provisions designed to protect women, and how these dynamics affect the implementation and effectiveness of such laws. The paper examines the historical development of legal mechanisms addressing gender-based violence, evaluates the gaps in law enforcement, and critically assesses how societal attitudes shape legal outcomes. It also explores successful models and reforms while recommending a multi-pronged strategy that includes legal reform, public awareness, and education to dismantle harmful norms.

*Keywords:*Violence against Women, Social Norms, Legal Frameworks, Gender-Based Violence, Patriarchy, Law Enforcement, Women's Rights, India, Socio-Legal Perspective, Gender Justice.

Radiation Shielding Efficiency of Eco-Friendly Composite Materials against Gamma and Neutron Radiation

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Abstract

The increasing development of nuclear usage in the fields of healthcare, energy, defence and aerospace necessitate efficient but/and sustainable radiation shielding applications. Conventional materials, e.g. lead and concrete, despite being effective, present a challenge to toxicity, weight and environmental hazards. In this paper, theoretical and recent progress on green composites which use natural fibers, waste polymers, and non-hazardous fillers such as bismuth oxide and Boron carbide have been investigated. It examines how gamma and neutron radiations interact with matter, and how to measure the shielding efficiency using mathematical representation- linear attenuation coefficient, half-value layer and macroscopic cross-section. The results confirm the possibility of sustainable composite materials as a part of the contemporary radiation protection field, as it is a much safer, lighter, and environmentally conscientious alternative. These new ideas could be used in new designs of materials to be used in variety of shielding applications.

*Keywords:*Radiation shielding, Eco-friendly composites, Gamma radiation, Neutron radiation, Natural fibre.

भारत में सतत ऊर्जा नीतियों के लिए शासनीय ढांचा

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सारांश

भारत जैसे विकासशील देश के लिए ऊर्जा सुरक्षा और पर्यावरण संरक्षण एक साथ सुनिश्चित करना एक बड़ी चुनौती है। बढ़ती जनसंख्या, औद्योगीकरण और शहरीकरण ने ऊर्जा की मांग को बढ़ा दिया है, जिसके समाधान हेतु सतत और नवीकरणीय ऊर्जा स्रोतों को बढ़ावा देना अत्यंत आवश्यक हो गया है। यह शोध पत्र भारत में सतत ऊर्जा नीतियों के शासन ढांचे की समीक्षा करता है, जिसमें नीति निर्माण से लेकर कार्यान्वयन तक की प्रक्रिया का विश्लेषण किया गया है।भारत सरकार द्वारा बनाए गए प्रमुख संस्थानों जैसे नवीन और नवीकरणीय ऊर्जा मंत्रालय डछत्म ऊर्जा मंत्रालय, नीति आयोग और राज्य विद्युत नियामक आयोग की भूमिका को विस्तार से समझाया गया है। शोध में राष्ट्रीय सौर मिशन, पवन ऊर्जा नीति, ऊर्जा संरक्षण अधिनियम 2001 जैसी नीतियों के प्रभावों का भी विश्लेषण किया गया है। साथ ही, ग्रीन एनर्जी ओपन एक्सेस नियम और इलेक्ट्रिक वाहन नीति जैसे हालिया प्रयासों पर भी चर्चा की गई है। पेरिस जलवायु समझौता, सतत विकास लक्ष्य ैक्ळे) और प्दजमतदंजपवदंस ैवसंत ।ससपंदबम जैसी अंतरराष्ट्रीय प्रतिबद्धताओं में भारत की भागीदारी को भी समझाया गया है। शोध यह निष्कर्ष निकालता है कि भारत ने कई सकारात्मक पहलें की हैं, परंतु वित्तीय संसाधनों की कमी, तकनीकी चुनौतियाँ, और नीति समन्वय की समस्याएँ अब भी मौजूद हैं। शासन ढांचे को और अधिक प्रभावी बनाने हेतु विकेंद्रीकरण, डेटा आधारित योजना, जनभागीदारी और अनुसंधान को बढ़ावा देने की सिफारिश की गई है। शोध अंततः शासन ढांचे को और प्रभावी, समावेशी तथा उत्तरदायी बनाने हेतु व्यावहारिक सुझाव प्रदान करता है। यह अध्ययन ऊर्जा नीति निर्माताओं, अनुसंधानकर्ताओं तथा प्रशासनिक निकायों के लिए उपयोगी दिशा–निर्देश प्रस्तुत करता है।

महत्वपूर्ण शब्द: ऊर्जा सुरक्षा, अनुसंधान ऊर्जा, मंत्रालय, सतत विकास

Synthesis, Characterization and Biological Activity of Novel Schiff Base Derived Multifunctional Metal Complexes

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Abstract

In the present study, a series of novel Schiff base ligands were synthesized through the condensation reaction between selected aldehydes and amines. These ligands were further employed to prepare multifunctional metal complexes with transition metals such as Cu(II), Ni(II), Co(II), and Zn(II) under controlled conditions. The synthesized compounds were thoroughly characterized using a range of analytical and spectroscopic techniques including FT-IR, UV-Vis, NMR, elemental analysis, magnetic susceptibility, molar conductivity, and mass spectrometry to confirm their structural composition and coordination behavior. The spectral data indicated that the Schiff base ligands coordinated to the metal centers in a bidentate or tridentate fashion, depending on their functional groups. The geometry of the metal complexes was proposed based on electronic spectral and magnetic moment measurements. The biological potential of both ligands and their corresponding metal complexes was evaluated by in vitro antimicrobial assays against selected bacterial and fungal strains. The results revealed that metal complexes exhibited enhanced biological activity compared to the free ligands, suggesting the role of metal coordination in increasing bioefficacy. This study highlights the significance of Schiff base metal complexes as promising candidates for the development of new antimicrobial agents with multifunctional properties.

Environmental and Technological Aspects of Renewable Energy: Climate Change, Technological Innovations, and Sustainable Solutions for Urban and Rural development

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Abstract

This research paper explores the interconnectedness of climate change, renewable energy resources, technological innovations, and the imperative of sustainable energy systems for both urban and rural development. As climate change escalates environmental challenges globally, the shift toward renewable energy has become central to mitigating carbon emissions and fostering long-term energy security. The paper analyzes the environmental impact of conventional energy systems, highlights cutting-edge technological advancements in the renewable sector, and discusses integrated strategies for implementing renewable energy solutions across different socio-economic contexts. This article discusses the potential for integrated systems in the stationary and portable power market in response to the critical need for a cleaner energy technology. Anticipated patterns of future energy use and consequent environmental impacts (acid precipitation, ozone depletion and the greenhouse effect or global warming) are comprehensively discussed in this paper. Throughout the theme several issues relating to renewable energies, environment and sustainable development are examined from both current and future perspectives.

Keywords: Socio – economic impact,ozone depletion, sustainable development.

Preparation and Storage of Fish Burger from Low- Priced Pangus Catfish

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Abstract

The improved fish burger made from Pangus fish with various additives showed changes in composition compared to the fish mince. It had lower moisture, pH, and protein contents but higher lipid and ash contents. Among the tested levels of mashed potato, the burger with 25% mashed potato had the best sensory performance and was recommended for commercial production. During storage at room temperature (28ºC), the sensory attributes of the burger declined significantly over time. However, when stored at refrigeration temperature (5ºC), the product exhibited better stability. Chemical analysis indicated that the TVB-N value, which indicates spoilage, increased progressively during storage at both room and refrigeration temperatures. Microbial load also increased significantly at both temperatures, but the growth rate was slower under refrigeration. Taking all the findings into account, it was concluded that the shelf life of the Pangus fish burger was very short, not exceeding 24 hours at 28ºC. However, refrigeration extended the shelf life, although it still had limited stability.

Keywords: Food additives, Room temperature, Refrigeration temperature, Fish mince.

Green Branding and Its Impact on Consumer Loyalty: An Empirical Analysis of Indian FMCG Sector

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Abstract

The paper finds out the effect of green branding on consumer loyalty in the Indian Fast-Moving Consumer Goods (FMCG) industry using a descriptive-analytical study. A structured questionnaire with 150 respondents was used to gather data in which aspects of consumer awareness, brand switching willingness to pay a premium, and consumer awareness regarding green initiatives were evaluated. Results demonstrate that 83.4 percent of consumers are somewhat ready to spend more in order to consume green products, and more than 63 percent of them have been crossing the brands on the basis of lack of sustainability. The social media and product packaging took the lead to become the most popular sources of green information. It makes a conclusion that green branding is really effective in strengthening consumer loyalty and provides tactical advantage to FMCG firms operating in India.

Keywords: Green Branding, Consumer Loyalty, Indian FMCG Sector, Sustainable Marketing, Brand Switching, Eco-Conscious Consumers

Machine Learning-Enabled Spectrum Management in Cognitive Radio Networks: A State-of-the-Art Review

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Abstract

Cognitive Radio Networks (CRNs) have become a cornerstone for addressing the escalating demand for efficient spectrum utilization in wireless communication systems. This paper provides a comprehensive review of recent advancements in artificial intelligence (AI) and deep learning (DL) techniques for dynamic spectrum management in CRNs. We explore AI-driven approaches for spectrum allocation, sensing, prediction, and energy management, emphasizing their advantages over traditional methods. Key frameworks, including Deep-Q learning, LSTM, and Smart Sensing Enabled Dynamic Spectrum Management (SSDSM), are analyzed for their impact on throughput, spectrum efficiency, and quality of service (QoS). Additionally, we briefly examine the application of machine learning in related fields, such as optical spectroscopy, to highlight the broader applicability of these techniques. A new contribution is presented, involving the analysis of a performance comparison chart between Normal CRN and AI-based CRN, correcting a labeling error and providing insights into AI's impact on spectrum management. The paper also addresses challenges such as data nonlinearity, computational complexity, and energy constraints, proposing future research directions for beyond 5G (B5G) and 6G networks.

*Keywords:*Cognitive Radio Networks, Dynamic Spectrum Management, Artificial Intelligence, Deep Learning, Spectrum Prediction, Quality of Service, Energy Efficiency

Traditional Methods of Fishing and Fish Processing

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Abstract

In Raniganj district Araria, Bihar, traditional fishing and fish processing are important industries. In Raniganj , fishing and fish processing are linked to employment, culture, and food preservation. The purpose of this study was to identify the traditional fish processing methods used in Raniganj as well as the financial standing of the fisherwomen who participate in fish preparation. Between July and December 2023, a survey was conducted at five local marketplaces and a few fishing colonies to gather data. The methods of fish processing, preservation strategies, and the financial standing of fisherwomen were investigated through in-person interviews and on-site observations. It was discovered that the fisherwomen's economic situation was insufficient. The fisherwomen wish to flourize the business by producing processed fish on a wide scale. Investigations revealed that women were actively involved. The fish that was treated using the conventional way were deemed affordable and suitable by the clients.

Keywords: Economic status of fisherwomen, fish processing, traditional methodology.

Comparative Study on the Level of Stress between High School Students Participating and Non-Participating in Co-Curricular Activities

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Abstract

This paper analyses the level of stress between the high school learners who participate in co-curricular activities. Data were measured using descriptive and comparative survey design approach where 150 students took part in filling a structured questionnaire that involved the Perceived Stress Scale (PSS). The results showed that the population that participated in co-curricular activities like sports and music had greatly reduced levels of stress as compared to the non-participants. The more time was spent in such activities, the higher the emotional well-being. The emotional well-being was lower in non-participants, as they faced a lot of stress because of academic pressure and inability to manage their time properly. The findings communicate the importance of co-curricular activities in stress management and healthier whole development of students.

Keywords: Stress levels, Co-curricular activities, High school students, Academic pressure, Time management, Emotional well-being.

Role of Mathematical Models in Simulating Disease Dynamics And Guiding Public Health Policy

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Abstract

This study presents a mathematical modeling approach to simulate the transmission dynamics of COVID-19 in India using the SEIR (Susceptible–Exposed–Infectious–Recovered) compartmental framework. Leveraging time-series epidemiological data from the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University, the model was calibrated to reflect India's initial outbreak conditions during the period from March 2020 to December 2021. The simulation aimed to reproduce the progression of the pandemic under a baseline, non-intervention scenario by solving a system of ordinary differential equations representing disease transitions. Model accuracy was assessed by comparing predicted infectious counts to actual active case data, yielding an R^2 score of −0.2339, RMSE of 91.54, and MAE of 39.85. These results indicate a significant deviation from real-world trends, largely due to fixed parameter assumptions and the exclusion of policy-driven dynamics. While the SEIR model provides foundational insight into disease progression, its baseline configuration demonstrates limited predictive capacity in highly dynamic and heterogeneous contexts. The findings emphasize the need for time-varying parameters, policy inputs, and data-driven adaptations in future epidemiological modeling efforts.

Keywords: SEIR Model, COVID-19 Simulation, Infectious Disease Modeling, Epidemiological Forecasting, India Pandemic Dynamics

Assessing the Socio-Cultural Acceptance of Wind Energy Projects in Indigenous Communities

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Abstract

The increase in the use of renewable energy, especially wind energy, is the key to climate success, yet it will not materialize solely based on technical efficiency but will rely on the social and cultural acceptance. This paper explores the questions of socio-cultural acceptability of wind energy projects within indigenous population based on perceptions, individual interpretation of cultural issues, the rate of participation and the general support. The mixed-methods approach was used to collect data among 250 members of the community through structured surveys and 30 semi-structured interviews in three indigenous regions affected by wind projects. The findings indicate that although the desire to use wind energy is fairly high in the environment, the cultural attachment to land, nonexistent involvement in decision-making, and the perceived lack of regard to traditional values are major setbacks to acceptance. The correlation between participation and awareness plays a positive influence in relation to acceptance; however, cultural issues are a good negative vice. Spiritual value of land and the need of all-embracing governance are also underlined in qualitative accounts. The research further postulates that the consultation process and cultural sensitivity, as well as empowerment of the indigenous people is key in the sustainable and ethical execution of wind energy initiatives. It argues in favour of the policy frameworks that focus on energy justice and indigenous autonomy in renewable energy transitions.

Keywords: Wind energy, Indigenous communities, Socio-cultural acceptance, Participation, Renewable energy policy, Energy justice, Cultural concerns.

भारत में नवीकरणीय ऊर्जा अवसंरचना को बढ़ावा देने में सार्वजनिक-निजी भागीदारी की भूमिका

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Abstract

प्रस्तुत कार्य भारत में नवीकरणीय ऊर्जा अवसंरचना के विकास में सार्वजनिक-निजी भागीदारी (PPP)की भूमिका का आलोचनात्मक विश्लेषण है। यह अध्ययन मात्रात्मक शोध डिज़ाइन पर आधारित है, जिसमें वर्णनात्मक और प्रक्षेपीय सांख्यिकीय विधियों जैसे पीयरसन सहसंबंध (Pearson Correlation)का उपयोग किया गया है। इसके निष्कर्षों से स्पष्ट होता है कि PPPपहलों की प्रभावशीलता और नवीकरणीय ऊर्जा की क्षमता वृद्धि तथा परियोजना कार्यान्वयन के बीच एक सशक्त सकारात्मक सहसंबंध मौजूद है। गुजरात और मध्य प्रदेश जैसे राज्य जहां स्थापित क्षमता और परियोजनाओं की संख्या अधिक है, वे उदाहरणात्मक प्रदर्शन कर रहे हैं, जबकि झारखंड जैसे राज्य, जिनका प्रदर्शन निराशाजनक है, उन्हें संस्थागत सुदृढ़ीकरण की आवश्यकता है।क्षेत्रीय दृष्टि से देखा जाए तो, PPPके माध्यम से निवेश में सौर ऊर्जा प्रमुख भूमिका निभा रही है, जिसमें ₹23,000करोड़ से अधिक का निवेश देखा गया है, और यह ऊर्जा पहुंच, रोजगार सृजन तथा कार्बन उत्सर्जन में कमी पर उल्लेखनीय प्रभाव डाल रही है। इन उपलब्धियों के बावजूद, नियामक असंगतता, वित्तीय अंतर और भूमि अधिग्रहण जैसी चुनौतियाँ प्रमुख बाधाएँ बनी हुई हैं। यह शोध सुझाव देता है कि PPPकी प्रभावशीलता को सार्वजनिक क्षेत्र की क्षमता सुदृढ़ कर, जोखिम साझाकरण की पद्धतियाँ विकसित कर, और नीतिगत समन्वय सुनिश्चित कर बढ़ाया जा सकता है। हरित ऊर्जा संक्रमण के एक विश्वसनीय साधन के रूप मेंPPPकी उपयोगिता को दीर्घकालीन अवधि में प्रमाणित किया जा सकता है, और इसका समर्थन ARDLमॉडल, कोहेरेंस वेवलेट्स एवं वैश्विक केस स्टडीज़ से प्राप्त आंकड़ों द्वारा किया गया है।

मुख्यशब्द: सार्वजनिक-निजी भागीदारी (PPP),नवीकरणीय ऊर्जा, अवसंरचना विकास, भारत, ऊर्जा संक्रमण, सौर ऊर्जा।

Sustainable Development as Envisioned in Amitav Ghosh's The Great Derangement: Climate Change and Unthinkable

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Abstract

Sustainable Development is a way of human development that meets the needs of the present without compromising the safety of the environment and energy resources. The concept of sustainable development has gained currency in the wake of environmental degradation and climate change as these have posed threat to the existence of all living beings on the earth. The approach has taken into its consideration the future and possible extinction of human-beings and other living organisms from this planet, if reckless exploitation of the resources is not checked before it is too late. The earth has provided with us a limited treasure of non-renewable resources in the form of fossil fuel, coal, land etc. and human-beings are using these recklessly, without thinking of its hazardous effects on the overall health of the earth. We are not only exploiting these resources but also creating pollution at a large level that is going to change the climate of the earth to a dangerous extent. We have to adopt a balanced approach to the development at the present times so that our future generations do not suffer. The present paper is an attempt to understand the sustainable development as envisioned by the acclaimed writer of fiction and non-fiction in his book The Great Derangement: Climate Change and the Unthinkable.

Keywords: Sustainable, Development, Derangement, Environment, Climate, Resources, Exploitation etc.

Renewable Energy Integration and Its Role in Achieving Sustainable Development Goals (SDGS) In India

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Abstract

India's commitment to sustainable development and climate action has brought renewable energy to the forefront of its national agenda. As one of the world's fastest-growing economies with rising energy demands, India faces the dual challenge of ensuring energy security while minimizing environmental degradation. This review paper critically examines how the integration of renewable energy sources—such as solar, wind, hydro, and biomass—contributes to the achievement of key Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy), SDG 13 (Climate Action), and SDG 8 (Decent Work and Economic Growth). The paper synthesizes existing literature, government policy frameworks, and case studies to explore the role of renewable energy in reducing carbon emissions, enhancing energy access in rural and underserved regions, creating green jobs, and promoting inclusive economic development. It also highlights the technological advancements, policy initiatives like the National Solar Mission, and international collaborations that have accelerated India's renewable transition. Despite notable progress, the paper identifies significant challenges such as grid integration issues, financing barriers, policy inconsistency, and socio-environmental impacts. These barriers, if unaddressed, may hinder the long-term alignment of renewable energy initiatives with SDG targets. The review concludes that while renewable energy integration has made measurable contributions to India's SDG progress, a coordinated, interdisciplinary approach—combining innovation, policy reform, and community engagement—is essential for maximizing its impact. The findings offer strategic insights for policymakers, researchers, and energy planners aiming to build a sustainable, equitable, and resilient energy future for India.

Keywords: Renewable energy, Integration, Sustainable Development

Economic Viability and Policy-Driven Adoption of Rooftop Solar Systems in India: A State-Level Comparative Analysis

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Abstract

The economic viability and policy-driven adoption of rooftop solar systems represent a critical axis in India's quest for sustainable energy security. This research investigates inter-state differences in rooftop solar adoption across Ten Indian States using secondary data on installations, average electricity tariffs, subsidy percentages, urbanization rates, and household income levels. Descriptive statistics, correlation analysis, multivariate regression, and ANOVA were used to assess how economic and policy variables influence adoption patterns.The results reveal significant state-level variation in rooftop solar installations, not necessarily correlated with income or subsidy levels. Regression analysis suggests that subsidy percentage has a counterintuitive negative association with adoption, while income, tariff, and urbanization rates have minimal influence. ANOVA results further confirm that the difference in installations between high- and low-subsidy states is not statistically significant. These findings point to underlying structural and implementation inefficiencies in India's rooftop solar policy landscape.The study concludes that financial incentives alone are insufficient to drive adoption. Instead, factors such as policy execution, administrative transparency, consumer awareness, and innovative financing mechanisms are more crucial. The paper recommends moving toward decentralized, performance-based, and consumer-centric policies that go beyond subsidy-centric approaches. A reorientation of India's rooftop solar strategy toward holistic and context-sensitive planning will be essential for realizing its renewable energy potential.

Keywords: Green Energy, Rooftop Solar Photovoltaic, Financial Viability of Renewable Energy, Regression analysis in Energy policy formulation

The Influence of Neurochemistry on Entrepreneurial Behavior: A Neuro-scientific Perspective on Entrepreneurial Drive, Risk-Taking, and Decision-Making

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Abstract

Entrepreneurship is a complex psychological and behavioral phenomenon that involves creativity, innovation, risk-taking, and decision-making under uncertainty. While traditional studies have focused on sociocultural and economic factors, emerging research in neuroscience offers compelling insights into how neurochemistry influences entrepreneurial behavior. This abstract explores the intricate relationship between neurotransmitters and hormones—such as dopamine, serotonin, oxytocin, cortisol, norepinephrine, and testosterone—and core entrepreneurial traits.

From Compliance to Commitment: Re-imagining CSR for Sustainable Development

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Abstract

This research paper explores the transformation of Corporate Social Responsibility (CSR) from a compliance-driven obligation to a commitment-based strategic approach aligned with sustainable development. It examines the historical evolution of CSR, critiques the limitations of rule-based practices, and introduces the concept of commitment-based CSR, characterized by voluntary action, stakeholder engagement, long-term vision, and integration into core business strategy. The paper analyzes how this approach contributes directly to the United Nations Sustainable Development Goals (SDGs), offering real-world examples from companies such as Unilever, Tata, and Interface. It also outlines the business and societal benefits of commitment-based CSR, including enhanced reputation, innovation, and systemic social impact. Challenges such as short-termism, measurement gaps, and organizational inertia are addressed, along with practical strategies for successful implementation. The findings emphasize that genuine corporate commitment is not only vital for sustainability but also serves as a catalyst for resilience, ethical leadership, and inclusive global progress.

Bioenergy from Agricultural Residue: Challenges and Potentials in Northern India

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Abstract

Still a lot of agricultural wastes i.e. paddy straw, wheat straw, sugarcane bagasse and cotton stalks etc. are generated in northern India and largely go to waste or are thrown in the open fields resulting in the worst of air pollution and emission of carbon. The paper examines the problem and opportunity of transforming these wastes into bioenergy as a sustainable way forward to generating clean energy as well as managing the environment. The study has provided both secondary and primary data based on the reports published by the government and related institutions reports respectively and also compared reports of both Punjab and Haryana by surveying 400 farms. These results show that the excess amount of biomass is almost 89 million of tons yearly, and energy that can be estimated is more than 1,200 petajoules. Large-scale adoption is however hindered by logistical issues, unavailability of infrastructure, low farmers awareness and poor governance structuring. The research prescribes the incorporation of policies, or decentralized biomass and rural inducements and the public-private tie-ups to unlock this unexploited source of energy. These understandings have developed a situation of discussion about renewable energy transformation, sustainable farming, and climate change adaptation in India.

*Keywords:*Bioenergy, Agricultural Residue, Northern India, Stubble Burning, Biomass Potential, Renewable Energy, Rural Energy Access, Environmental Sustainability.

Realization of sustainable Development goals and Energy security through ecopoetry

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Abstract

The welfare of human beings is directly linked to the health of the planet Earth. So, they have a responsibility towards her. They must direct their actions towards protecting and preserving the planet and her natural resources. The development needs of the present generation should be met in such a manner that it does not compromise the needs of the future generations. The Sustainable Development Goals (SDGs) talk about this. The ever-increasing demand for energy caused by economic expansion, population growth, new energy usage and growth in income has made Energy Security a pressing concern. That is why countries of the world have made it a goal that their economies function without disruptions in energy supply for the people. They are also thinking about and opting for alternate renewable energy sources for this purpose so as to reduce overdependence on energy sources like fossil fuels. Global consciousness is required among people about these issues. Literature can play an important role in this case to bring the global awareness and make people sensitive. Ecopoetry is a form of poetry that explores the relationship between humans and the natural world, often with a focus on environmental concerns and sustainability. The paper presented here thus aims to emphasize and justify the effectiveness of using selected Ecopoems, "The Peace of Wild Things" by Wendell Berry, "Fossil Fools" byAnne Layton-Bennet and "Earth Day" by Jane Yolen in the realization of the Sustainable Development Goals and Energy Security.

Keywords: Sustainable Development Goals, Energy Security, Ecopoetry, Role of Ecopoetry, Raising global awareness

Environmental and Technological Aspects of Renewable Energy

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Abstract

The rising worldwide demand for sustainable and clean energy has brought renewable energy to the forefront of global energy policy and development strategy. The limited nature of fossil fuels, their environmental consequences and the increasing necessity of mitigating climate change have collectively emphasized the need towards renewable energy. Climate change is one of the greatest global challenges of the 21st century. It is driven largely by the addition of greenhouse gases such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The energy sector is the largest source of greenhouse gas emissions, mainly due to the burning of fossil fuels for electricity, heat, transportation and industry. Renewable energy—derived from naturally replenished sources like sunlight, wind, water, biomass, tidal and geothermal heat—offers an influential solution for de-carbonizing the energy sector and reducing greenhouse gas emissions. The global transition towards renewable energy is gaining impetus due to growing concerns over climate change, energy security and sustainable development. However, the integration of renewable energy sources into traditional power grids presents numerous technological challenges. The main technological challenges associated with renewable energy integration into the grid presents practical and emerging solutions to overcome them. As the world population is increasing continuously and industrialization is growing speedily, the demand for energy is rising. However, the climate adversity and environmental dilapidation demand a new paradigm. The future of sustainable energy is shaped not just by policy and public spirit, but by innovation and emerging trends that redefine how energy is produced, stored, distributed and consumed. The main objective of this paper is to provide a comprehensive analysis of the environmental and technological aspects of renewable energy. It explores the major types of renewable energy technologies and examines how they affect the natural environment. It also discusses technical innovations, challenges in implementation and the prospects for integrating renewable energy into global power systems. Ultimately, it underscores the critical role of renewable energy in combating climate change, promoting sustainable development and shaping the energy future.

Keywords: Global, strategy, emission, integration, innovation, comprehensive, efficiency.

Role of Prime numbers in Mathematics

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Abstract

Prime numbers, the indivisible building blocks of the integers, have captivated mathematicians for centuries due to their fundamental nature and deep properties. Defined as natural numbers greater than 1 that have no positive divisors other than 1 and themselves, primes are central to number theory and underlie many modern applications in cryptography, coding theory, and computational mathematics. Despite their apparent randomness, prime numbers exhibit intriguing patterns that have inspired profound conjectures and theorems, such as the Prime Number Theorem and the Riemann Hypothesis. Recent advances in both theoretical and computational approaches have led to improved algorithms for prime testing and large prime generation, which are crucial for secure encryption systems. This abstract introduces the significance of prime numbers, their mathematical mysteries, and their evolving role in both pure and applied disciplines. Ongoing research continues to explore their distribution, density, and unexpected appearances across diverse mathematical structures and real-world systems. Prime numbers not only serve as the foundational elements of arithmetic but also play a crucial role in various advanced mathematical domains. One of the most significant achievements in number theory is the Prime Number Theorem, which describes the asymptotic distribution of primes among the natural numbers, showing that primes become less frequent as numbers increase, yet follow a predictable density. This insight opened doors to deeper analytical investigations, particularly through the lens of complex analysis and the Riemann zeta function.

The Problem of Childless Aging in Haryana: A Sociological Perspective

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Abstract

This study examines the social exclusion and vulnerabilities faced by childless older adults in rural Haryana, a region deeply rooted in patriarchal norms where caregiving and inheritance are traditionally based on bloodline ties. Utilizing qualitative interviews with childless elders and key stakeholders, the research uncovers critical challenges including social isolation, economic insecurity, psychological distress, and lack of access to welfare schemes and healthcare services. Women are disproportionately affected, facing greater stigma and exclusion. The erosion of traditional family-based support systems, combined with inadequate formal social security mechanisms, exacerbates their marginalization. The study calls for urgent, targeted policy interventions that recognize childless elders as a distinct at-risk group. Recommendations include strengthening community-based care structures, improving access to pensions, and ensuring gender-sensitive health and social services. By addressing an often overlooked population, the research contributes to the broader discourse on aging in India, particularly at the intersection of childlessness, gender, and rural disadvantage.

A Study of Independent Domination in Block Designs: Focus On PBIB-Designs

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Abstract

Partially Balanced Incomplete Block (PBIB) designs are the primary subject of this investigation of independent dominance in block designs. In the combinatorial structure of PBIB-designs, where treatments and blocks are depicted as vertices and edges, respectively, the graph-theoretic parameter known as independent dominance is applied. Within the framework of PBIB-designs defined by different association schemes, the study delves into the theoretical foundations, computation, and consequences of independent domination. Finding autonomous dominating sets that effectively represent all treatments while minimizing redundancy is the goal of the study, which offers a paradigm for doing so by examining the links between blocks and treatments. Experiment design optimization using independent dominating parameters is demonstrated in case studies of 2-associate and 3-associate PBIB-designs. This study sheds light on the structural features of PBIB-designs by demonstrating the interaction between graph theory and combinatorial design theory. In situations where resources are limited, it highlights the value of independent dominance as a method for assessing and improving block designs' efficiency. Our current understanding of block designs and how to optimize them for use in experimental planning, data analysis, and resource allocation is enhanced by these findings.

Keywords: Graph theory, Combinatorial, Block Design, Independent domination.

To Assess the Key Privacy Concerns and Risks Arising from the use of Digital Technologies and Data Collection in E-Governance Initiatives in India

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Abstract

The rapid digitization of governance in India has brought transformative benefits through e-governance initiatives, enhancing transparency, efficiency, and citizen participation. However, the increasing reliance on digital technologies and extensive data collection raises significant concerns regarding privacy and data security. This study aims to assess the key privacy risks emerging from e-governance systems in India, focusing on issues such as data breaches, lack of informed consent, inadequate regulatory frameworks, and surveillance concerns. With the expansion of projects like Aadhaar, Digital India, and various state-level e-governance portals, the collection and processing of personal data have outpaced the development of robust privacy safeguards. The research underscores the urgent need for a comprehensive data protection regime, public awareness, and accountability mechanisms to ensure that digital governance does not compromise individual privacy rights. Recommendations include stronger legal frameworks, privacy-by-design principles, and the promotion of digital literacy among citizens to foster a secure and inclusive digital governance ecosystem.

Keywords: Digital, privacy, e-governance, technology.

Evaluation the Performance Using Surveying Instruments for Road Shoulders of Soil to Complete the Project within the Sepcifice Cost, Time and Quality

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Abstract

In surveying engineering we are finding leveling with different instruments in various different fieldworks. So, I am working on different and different instrument finding leveling in surveying. On ours construction industry various instrument are use in leveling likes as Auto level, Dumpy level, Theodolite and total station. In this all instrument we finding leveling in field works like as road, railways, building, sewerage line etc. In this chapter we discuss how to find out leveling and what is easy process in road shoulders condition. In this process I am analysis various situations like as project cost, timing. If the project's cost is high likes as working on national highway or express way and timing of the projects is less in this case I am using total station because of the total station is fastest process of doing working on such types of works. If we are using auto level / dumpy level on that condition we are not comfortable with this instruments because of timing is more required at this projects. But another project likes as a streets making of 100m/200m. In this condition we have not prefer total station because of that condition I am able to working with total station. Total station is required skill labors and the cost of total station isvery high as comparisons of auto level /dumpy level and operating system of auto level / dumpy level isto easy as comparison of auto level. If we are working a small projects or low cost project like as 5-10 lakh so, that condition we are not effort total station and skills workers because of the project cost is low as comparison of expanses.

Keywords: Auto level, Dumpy level, Theodolite, Total station.

Technological Innovations and Sustainable Energy Strategies to Combat Climate Change: Advancing Renewable Energy for Urban and Rural Development

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Abstract

This study focuses on the current technological advancements in the field of mechanical engineering systems and sustainable energy policies that can effectively help in combating the problem of climate change with the use of renewable energy sources in urban and rural areas. It brings to the fore such developments as aerodynamic optimization of wind turbines, thermal storage improvements in solar, and Organic Rankine Cycle technology to recover waste heat, all of which can make systems more energy efficient and with lower carbon footprints. The paper also addresses realistic solutions such as rooftop PV, smart inverters, district cooling and rural mini-grids that respond to the energy needs of the various locations. Backed by real-life case studies of India and Kenya, the results highlight the critical importance of mechanical engineering in the transition to a resilient and low-carbon energy future, which provides solutions that are scalable to the local needs, as well as minimizing climate change impacts globally.

Keywords: Renewable energy, Climate change mitigation, Wind turbine, solar thermal storage, Organic Rankine Cycle (ORC), Urban and Rural Development.

Forensic Document Examination in Green-Collar Crime: Challenges and Case Studies

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Abstract

Green-collar crimes, which are defined as "environmental crimes committed through legal or regulatory deception," are becoming serious obstacles to sustainable development. A common aspect of these crimes are the false or forged documents one might create, including environmental impact assessments (EIAs), air emissions audit reports, pollution control permits, and carbon credit papers.

This paper will study the significant role Forensic Document Examination (FDE) can play, for example, in discovering cases of document fraud in green-collar crime. Using scientific methods such as ink and paper analysis, handwriting and signature authentication, electrostatic detection (ESDA), digital metadata forensics and multispectral imaging; FDE utilises identifiable techniques to verify the authenticity of environmental documents and the accuracy of the information contained in these various environmental-related documents.

Through several example case studies, the paper highlights credible examples of FDE in green-collar crime, such as deceitful clearances for illegal mining, falsified emissions inspections for pollution through environmental auditing, and deceitful carbon credit report writing. It will also outline main areas of concern for FDE including increased digitization of documents, lack of collaboration with forensic agencies and environmental agencies, and the various technological aspects associated with reports in subject-matter areas at both report writing and polices levels.

This study argues that FDE should be routinely integrated into environmental policy enforcement mechanisms and compliance systems using an interdisciplinary approach that incorporates forensic science, environmental governance and digital technologies, which will allow for better practices in detecting, preventing and prosecuting the environmental fraud.

Keywords: Forensic Document Examination, Green-Collar Crime, Environmental Forgery, Sustainable Development, Carbon Credit Fraud, EIA, Digital Document Tampering

The Role of Work-Life Balance in Employee Productivity

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Abstract

Work-life balance has emerged as a critical determinant of employee well-being and organizational success in the 21st century. As work environments become more demanding and technology continues to blur the boundaries between professional and personal life, maintaining a healthy balance has become increasingly challenging. This research paper investigates the impact of work-life balance on employee productivity, exploring how factors such as flexible work arrangements, organizational support systems, employee autonomy, and workplace culture influence overall performance. Through an extensive review of existing literature and empirical data collected via surveys and interviews, the study identifies the positive correlation between work-life balance and employee output, job satisfaction, and mental health. Furthermore, the paper discusses the adverse effects of poor work-life balance, such as stress, burnout, absenteeism, and reduced engagement. The findings underscore the importance of strategic human resource practices in fostering a culture that supports balance, ultimately contributing to higher productivity, lower turnover, and sustained organizational growth.

Keywords: Productivity, influence, interviews, organizational growth, correlation

Visual VS Conceptual Understanding: Addressing Misconceptions through Molecular Modeling in Inorganic Chemistry

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Abstract

Understanding inorganic chemistry presents a dual challenge: mastering both abstract concepts and their visual-spatial representations. Students often struggle with misconceptions rooted in either or both of these areas. This study explores the effectiveness of molecular modeling tools in improving both visual and conceptual understanding in inorganic chemistry. Utilizing a mixed-method approach involving diagnostic tests, intervention via 3D modeling software, and interviews, the study compares traditional lecture-based instruction with modeling-enhanced pedagogy. Results indicate significant improvement in students' conceptual clarity and reduction in persistent misconceptions. The findings suggest that integrating molecular visualization with conceptual teaching strategies can bridge the gap in students' understanding, particularly in complex topics like coordination compounds and molecular geometry.

Keywords: Inorganic chemistry, misconceptions, molecular modeling, visual understanding, conceptual understanding, coordination compounds, pedagogy.

संस्कृत शिक्षण पद्धति का विकास : पारंपरिक से डिजिटल तक

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सारांश

वर्तमान तकनीकी युग में शिक्षा के क्षेत्र में तीव्र परिवर्तन हो रहे हैं, और भाषाई शिक्षण भी इससे अछूतानहीं है। संस्कृत, जो कि भारतीय ज्ञान, संस्कृति और दर्शन की अमूल्य धरोहर है, उसकी शिक्षण पद्धति ने समयके साथ अनेक परिवर्तन देखे हैं। यह शोध कार्य संस्कृत शिक्षण पद्धति का विकास : पारंपरिक से डिजिटल तकइस भाषा के शिक्षण में आए बदलावों का विश्लेषण करता है – प्रारंभिक गुरुकुल प्रणाली से लेकर आज कीडिजिटल शिक्षण विधियों तक। प्राचीन काल में संस्कृत शिक्षण मुख्यतः मौखिक परंपरा पर आधारित था।गुरुकुलों में विद्यार्थी गुरु से प्रत्यक्ष रूप से ज्ञान प्राप्त करते थे। यह प्रणालीआचार्य-शिष्य परंपरा पर आधारित थी, जहाँ आत्मीयता और व्यक्तिगत मार्गदर्शन प्रमुख था । औपनिवेशिक काल में अंग्रेजी शिक्षा प्रणाली केआगमन से संस्कृत की स्थिति और भी कमजोर हुई, परन्तु कुछ विद्वानों और संस्थानों के प्रयास से यह संरक्षितरही। स्वतंत्रता के बाद, भारत सरकार और विभिन्न शैक्षणिक संस्थाओं ने संस्कृत के संरक्षण और प्रचार-प्रसार केलिए योजनाएँ बनाई। लेकिनइस समय भी शिक्षण विधि पारंपरिक रही – कक्षा आधारित, ग्रंथ-पठन पर केंद्रित।21वीं सदी में डिजिटल क्रांति ने संस्कृत शिक्षण में भी परिवर्तन लाया है। ऑनलाइन पाठ्यक्रम, मोबाइल एप्स,यूट्यूब चैनल, वेबिनार, ई-लर्निंग प्लेटफार्म (जैसे SWAYAM, NPTEL), और वर्चुअल क्लासरूम्स के माध्यमसे संस्कृत शिक्षा अब अधिक सुलभ और व्यापक हो गई है। विद्यार्थी अब विश्व के किसी भी कोने से संस्कृत सीखसकते हैं।डिजिटल उपकरणों ने संस्कृत को एक नया जीवन दिया है – जहाँ उच्चारण सुधार, इंटरऐक्टिव व्याकरणअभ्यास, तथा श्लोकों की ध्वनि और अर्थ की स्पष्टता संभव हुई है।अंततः यह स्पष्ट होता है कि संस्कृत शिक्षण पद्धति ने समय के साथ न केवल रूप बदला है, बल्कि यह भाषा अबआधुनिक तकनीक के साथ जुड़कर एक नवजीवन प्राप्त कर रही है ।

मुख्य बिंदु: डिजिटल, संसाधन, नवाचार, तकनीकी

Women and Energy Justice: Examining the Gender Dimension in India's Energy Access

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Abstract

This paper reflects a gender and energy justice nexus on how access to energy, in India, impacts gender health, economic inclusion, and leadership opportunities. Conducted on a mixed-methods basis in both rural and semi-urban areas, the study points out that although programs such as the Pradhan Mantri Ujjwala Yojana (PMUY) and the provision of electricity to rural areas have enhanced access on a technical level, technical access is not sufficient due to issues connected with price accessibility, inconsistency of supply, and social/social limitations. Women as the greatest users of energy, still carry the burden of the use of traditional fuels hence resulting to time poverty and health complications. The paper also establishes that the availability of dependable power sources increases women access to income and education. Nonetheless, women lack independence in the decisions that concern energy as it is predominantly male-dominated. These results are an urgent imperative to two demands of gender-sensitive policies and approaches to energy: They should be inclusive so that women have a position of access and control, and they should strengthen equitable growth.

Keywords: Energy justice, gender inequality, clean cooking fuel, women empowerment, rural India, PMUY, energy access

Telemedicine and Paramedical Integration for Sustainable Healthcare Access in Remote Areas

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Abstract

Access to quality healthcare remains a persistent challenge in remote and underserved regions due to geographical isolation, lack of medical infrastructure, and shortage of skilled professionals. This research explores the innovative convergence of telemedicine and paramedical services as a sustainable solution to bridge this healthcare divide. Telemedicine, which employs digital communication technologies to deliver medical services over distance, can be significantly enhanced by incorporating trained paramedical professionals as on-ground facilitators. These paramedics serve as the crucial link between remote patients and centralized healthcare systems, enabling functions such as basic diagnostics, sample collection, patient monitoring, and facilitating virtual consultations.

The study investigates this integrated approach in the context of the Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-being) and SDG 9 (Industry, Innovation, and Infrastructure). It highlights how the model contributes to sustainability by reducing travel-related emissions, lowering operational costs, and increasing healthcare accessibility and equity.

However, challenges such as poor internet connectivity, digital illiteracy, regulatory gaps, and the need for targeted training programs must be addressed for successful implementation. The paper concludes with strategic recommendations for policymakers, healthcare institutions, and educators to adopt and scale this model effectively, positioning it as a cornerstone for sustainable and inclusive healthcare delivery in the 21st century.

Keywords: Telemedicine, Paramedical Services, Sustainable Healthcare, Remote Areas, Rural Health Access, Digital Health, Healthcare Innovation, Community Health Workers, SDG 3, SDG 9, Healthcare Equity, Health Infrastructure, Mobile Health (mHealth), Health Technology Integration, Public Health Delivery.

High Output Flexible Piezoelectric Generator Synthesized Based On Mn-doped ZnO for Energy Harvesting Applications

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Abstract

With the rising global demand for energy particularly clean and renewable sources there has been notable progress in energy harvesting technologies in recent years. Devices in this domain are designed to efficiently capture ambient energy and convert it into usable electrical power. In our current study, we focus on enhancing the voltage output of piezoelectric materials through various methods. Specifically, Manganese-doped ZnO (MnZ) powders were synthesized using the co-precipitation technique and subsequently calcined at 600 °C. X-ray diffraction (XRD) analysis confirmed the successful phase formation of the synthesized ceramic powders. Calcined MnZ powders and MWCNT were incorporated into PVDF at a concentration of 3 wt.% to produce flexible composite films with an approximate thickness of 80 µm using the drop-casting technique. The structural properties of these films were further examined using XRD and Fourier Transform Infrared (FTIR) spectroscopy, revealing the presence of the electroactive β-phase. Scanning Electron Microscopy (SEM) was employed to study the morphology and microstructure of the composite films. The energy harvesting performance of the fabricated devices was evaluated using a mechanical shaker. The highest piezoelectric output voltage, measuring 70.4 V, was recorded for the MWCNT/MnZ/PVDF composite containing 3 wt.% MnZ. The fabricated PENG exhibited real-world applicability by successfully illuminating 6 LEDs. This study highlights the potential of lead-free piezoelectric nano-generators as a promising solution for self-powered wearable and portable electronic devices requiring low power.

माता-पिता की भागीदारी का छात्र के शैक्षणिक प्रदर्शन, प्रेरणा एवं आत्मसम्मान पर प्रभाव: एक सांस्कृतिक दृष्टिकोण

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सारांश

यह शोधपत्र माता-पिता की भागीदारी के प्रभाव का विश्लेषण करता है, जो छात्र के शैक्षणिक प्रदर्शन, प्रेरणा एवंआत्मसम्मान पर पड़ता है। इस अध्ययन में विभिन्न सांस्कृतिक संदर्भों में माता-पिता की भागीदारी के स्वरूप,प्रभावी तंत्रों और परिणामों का तुलनात्मक अध्ययन किया गया है। शोध में साहित्य समीक्षा, मौजूदा सैद्धांतिकमॉडलों और क्रॉस-कल्चरल अध्ययनों के आधार पर निष्कर्ष निकाले गए हैं। इस शोध का उद्देश्य न केवल माता-पिता की भागीदारी के सकारात्मक प्रभावों को रेखांकित करना है, बल्कि विभिन्न सांस्कृतिक पृष्ठभूमियों में इसकेप्रभावों में मौजूद अंतरों को भी समझना है, ताकि शैक्षिक नीतियों एवं हस्तक्षेपों में सुधार किया जा सके(एपस्टीन, 2001; फैन एवं चेन, 2001)।

Climate Change and Its Impact on Energy Resources

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Abstract

India's rapid economic growth and status as the third-largest global energy consumer make it particularly susceptible to the adverse effects of climate change. Increasing temperatures, unpredictable monsoons, extreme climatic events, and escalating energy needs are exerting significant pressure on the nation's energy systems. This paper explores how various energy resources in India such as coal, hydropower, solar, and wind are being affected by changing climate patterns. It also examines the influence of climate change on energy demand, infrastructure resilience, and long-term planning. Through an analysis of governmental data, national policies, and case studies from different Indian states, the paper highlights the country's efforts toward adaptation and energy transition, while addressing ongoing challenges. The findings emphasize the importance of embedding climate resilience into national energy strategies and suggest key actions like decentralization, technological advancement, and cooperative regional efforts as essential steps toward a secure and sustainable energy future for India.

Keywords: Climate change, Energy resources, Sustainability

Status of Women Education - A District-wise Analysis in Haryana

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Abstract

This comprehensive study examines the contemporary status of women's education across all districts of Haryana state, employing a multidimensional analytical framework to assess educational attainment, enrollment patterns, and socio-economic determinants. Through systematic district-wise analysis utilizing secondary data sources, this research identifies significant disparities in women's educational outcomes across geographic and demographic parameters. The study reveals that while Haryana has made substantial progress in women's education over the past decade, considerable inter-district variations persist, with literacy rates ranging from 54.08% to 84.07% across different districts. Key findings indicate that urbanization, economic development, and social infrastructure significantly influence women's educational participation. The research employs statistical analysis of enrollment data, completion rates, and dropout statistics to construct a comprehensive understanding of educational access and quality. Policy implications suggest the need for targeted interventions addressing regional disparities, with particular emphasis on rural-urban divides and socio-economic barriers. This study contributes to the broader discourse on gender equality in education and provides empirical evidence for evidence-based policy formulation in educational governance.

Keywords: Women's education, Haryana, district-wise analysis, literacy rates, gender parity, educational policy

Economic Viability of Solar Power Projects in Rural India: A Cost-Benefit Analysis

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Abstract

The intended idea of rapid growth in renewable energy technologies has provided a revolutionary measure to meet energy requirements of rural India at affordable costs with sustainable energy use. This paper compares the economic feasibility of solar photovoltaic (PV) with regular diesel-based energy systems in the rural areas. Simulated costs that were used in the cost-benefit analysis of the financial data are capital costs, operation and maintenance costs, and fuel savings over 10 years. Two major financial measures that were utilized to look at long-term viability included Net Present Value (NPV), Return on Investment (ROI) and the Payback Period. The results indicate that solar PV schemes, though they entail large capital investment costs, are made economically desirable with the passage of years as determined by their ROI of 38% and a positive NPV after eight years of finance. The total annual savings was INR 34,500 implying that the cost benefits will be constant over the years. The given research has decided that the practice could be regarded as environmentally sustainable since the adoption of solar PV in rural India seems to be financially viable, as well, has the potential to support energy access, reduce dependence on diesel, and boost economic resilience in underserved regions.

Keywords: Solar Photovoltaic (PV), Cost-Benefit Analysis, Rural Electrification, Payback Period, Return on Investment (ROI), Renewable Energy, India, Economic Viability, Sustainable Development

Big Data Analytics for Real-time Energy Demand Forecasting and Sustainable Resource Allocation

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Abstract

The rapid growth in global energy demand, coupled with the transition towards cleaner and more sustainable energy systems, has made real-time forecasting and efficient resource allocation imperative. This study explores the potential of big data analytics in enhancing energy demand forecasting and achieving sustainable resource use. By integrating machine learning models with massive datasets derived from smart meters, weather APIs, and historical consumption trends, this research demonstrates how real-time forecasting can aid in minimizing energy wastage, reducing operational costs, and optimizing grid reliability. The results show that long short-term memory (LSTM) models provide superior prediction accuracy over traditional statistical methods. This enables energy providers and policymakers to implement demand-side management strategies, align energy generation with consumption patterns, and support sustainable energy transitions. The interdisciplinary nature of this research—spanning data science, energy engineering, and environmental policy—highlights the essential role of technological innovation in addressing global energy security and sustainability challenges.

Paper-01

The Role of Work-Life Balance in Employee Productivity

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Abstract

Work-life balance has emerged as a critical determinant of employee well-being and organizational success in the 21st century. As work environments become more demanding and technology continues to blur the boundaries between professional and personal life, maintaining a healthy balance has become increasingly challenging. This research paper investigates the impact of work-life balance on employee productivity, exploring how factors such as flexible work arrangements, organizational support systems, employee autonomy, and workplace culture influence overall performance. Through an extensive review of existing literature and empirical data collected via surveys and interviews, the study identifies the positive correlation between work-life balance and employee output, job satisfaction, and mental health. Furthermore, the paper discusses the adverse effects of poor work-life balance, such as stress, burnout, absenteeism, and reduced engagement. The findings underscore the importance of strategic human resource practices in fostering a culture that supports balance, ultimately contributing to higher productivity, lower turnover, and sustained organizational growth.

Keywords: Productivity, influence, interviews, organizational growth, correlation

1. Introduction

In today's competitive and fast-paced business environment, organizations are increasingly recognizing the need to promote employee well-being as a strategic priority. One of the most significant aspects of employee well-being is work-life balance—the ability to effectively manage work responsibilities while maintaining a fulfilling personal life. The traditional boundaries between work and home have become increasingly blurred due to technological advancements, globalization, and evolving work cultures. Employees are expected to remain available and responsive beyond regular working hours, leading to extended workdays, increased stress levels, and a higher risk of burnout.

Work-life balance is no longer a luxury but a necessity for sustainable employee performance. Numerous studies have shown that employees who experience a good

balance between their work and personal lives tend to be more productive, satisfied, and loyal to their organizations. In contrast, an imbalance often results in disengagement, absenteeism, and reduced productivity, which can have significant implications for overall organizational performance.

This paper aims to explore the relationship between work-life balance and employee productivity, drawing from academic literature, organizational case studies, and primary research. The objective is to identify key factors that enable or hinder balance, examine their effects on performance, and offer practical strategies that organizations can adopt to support their workforce. By understanding the dynamics between personal well-being and professional efficiency, businesses can design more humane and effective workplace policies that benefit both the employee and the organization.

2.Literature Review

2.1 Definition and Dimensions of Work-Life Balance

Work-life balance (WLB) refers to the ability of employees to meet both work and personal life demands effectively (Greenhaus &Beutell, 1985). It includes time balance, involvement balance, and satisfaction balance across work and life domains. Researchers suggest that WLB is achieved when there is minimal conflict between professional and personal responsibilities and when an individual feels content with their role performance in both spheres (Clark, 2000).

2.2 Importance of Work-Life Balance in Enhancing Productivity

Numerous studies have linked work-life balance to various positive organizational outcomes, particularly employee productivity. Employees with better work-life balance tend to show higher levels of engagement, motivation, and overall performance (Kossek& Ozeki, 1998). A balanced lifestyle enhances mental well-being, reduces absenteeism, and fosters creativity.

Table 1: Summary of Key Studies Linking Work-Life Balance and Productivity

Author(s)	Year	Focus	Findings
Greenhaus &Beutell	1985	Work-family conflict	High conflict reduces employee satisfaction and performance.
Kossek & Ozeki	1998	Meta-analysis on WLB outcomes	WLB positively correlates with job satisfaction and commitment.
Bloom et al. (Stanford)	2015	Remote work in Chinese travel agency (Ctrip)	Productivity rose by 13% with work-from-home options.
Allen et al.	2013	Flexible work arrangements	Flexibility improves engagement and reduces turnover.
Gallup	2022	Employee well-being and performance	Well-being increases employee productivity by 21%.

2.3 Theoretical Frameworks Supporting the Link

Spillover Theory: This theory posits that experiences in one domain (work or home) affect the other. Positive spillover, such as job satisfaction, can enhance personal life, while negative spillover, such as stress, reduces overall effectiveness.

Conservation of Resources (COR) Theory: Hobfoll (1989) emphasizes that individuals strive to retain and protect their resources (time, energy). Poor work-life balance leads to resource depletion, resulting in burnout and poor productivity.

2.4 Factors Affecting Work-Life Balance

Table 2: Organizational and Personal Factors Impacting Work-Life Balance

Factors	Description
Flexible Work Hours	Allowing employees to choose work schedules improves autonomy and efficiency.
Managerial Support	Leaders who respect boundaries enhance employee morale and reduce stress.
Childcare and Family Support	Access to dependent care improves focus and reduces absenteeism.
Job Demands	Excessive workload leads to time pressure and reduced personal satisfaction.
Technology	While enabling flexibility, it also causes over-connectivity and burnout.

2.5 Case Study: Google's Work-Life Balance Initiatives

Overview:
Google is widely recognized for fostering a supportive work-life culture. The company offers on-site services such as child care, gyms, healthy food options, and nap pods to reduce time spent on personal chores and promote well-being.

Initiatives:

20% Time Policy: Employees can spend 20% of their work time on passion projects.

Remote Work Support: Strong infrastructure for remote teams, especially post-COVID-19.

Wellness Programs: Mental health days, mindfulness courses, and burnout prevention training.

Outcomes:

Employee satisfaction at Google consistently ranks among the highest in tech.

High retention rates and increased innovation through employee-led initiatives.

2022 internal HR report showed a 15% increase in self-reported productivity among employees who felt they had good work-life balance.

2.6 Gender and Cultural Perspectives

Work-life balance challenges vary based on gender and cultural context. Women, especially working mothers, often report higher levels of work-family conflict. In collectivist cultures (e.g., India, Japan), family obligations are more deeply ingrained, making balance harder to achieve without organizational support (Rajadhyaksha& Smita, 2004).

2.7 Cultural and Gender Dimensions

Women face a greater challenge in balancing work and domestic roles, particularly in traditional or patriarchal societies. In collectivist cultures (e.g., India, Japan), employees often prioritize family over work, requiring tailored policies for effectiveness (Rajadhyaksha& Smita, 2004).

3. Methodology

A **mixed-methods research design** was adopted, combining both **quantitative** and **qualitative** data collection techniques to ensure depth and validity of findings.

3.1 Research Design

This study follows an **exploratory-descriptive research design**.

Exploratory: To understand how organizations currently approach work-life balance.

Descriptive: To measure how different aspects of work-life balance correlate with employee productivity levels.
This dual approach allows for both statistical correlation and contextual understanding.

3.2 Population and Sample

Target Population: Employees working in corporate organizations across sectors such as IT, education, banking, and healthcare.

Sample Size: 150 participants were selected for the quantitative survey.

Sampling Technique: **Stratified random sampling** was used to ensure diversity in terms of gender, age group, work experience, and industry type.

Inclusion Criteria: Full-time employees with a minimum of 1 year of continuous employment in their current organization.

3.3 Data Collection Methods

A. Primary Data

(i) Questionnaire Survey

A structured questionnaire was developed using a **5-point Likert scale** (1 = Strongly Disagree, 5 = Strongly Agree), covering:

- Work hours and flexibility
- Stress and burnout levels
- Satisfaction with current WLB policies
- Self-assessed productivity and motivation
- Managerial support and organizational culture

Example Questions:

- *"I feel I have enough personal time after work."*
- *"My organization supports work-life balance initiatives."*
- *"Work-related stress affects my personal life."*

(ii) Semi-Structured Interviews

10 HR managers and 10 senior employees were interviewed to gather qualitative insights about how WLB strategies are implemented and perceived.

B. Secondary Data

Academic journals, company case studies, HR reports, and government labor statistics were reviewed to provide context and theoretical grounding.

3.4 Research Tools

- **Survey Platform**: Google Forms and Microsoft Excel
- **Interview Recording**: Zoom and voice recorders (with consent)
- **Reliability Testing**: Cronbach's Alpha used to test internal consistency of questionnaire items (target $\alpha \geq 0.7$)

3.5 Data Analysis

Quantitative Data:

- Descriptive statistics (mean, median, standard deviation)
- Correlation analysis (Pearson's r) to identify the relationship between WLB and productivity
- Regression analysis to predict productivity based on WLB dimensions

Qualitative Data:

- Thematic analysis of interview transcripts
- Coding of recurring themes such as "flexibility," "managerial support," and "burnout"

- NVivo software used for organizing themes

3.6 Ethical Considerations

- All participants were informed about the purpose of the study and gave their informed consent.
- Anonymity and confidentiality were strictly maintained.
- No personal or sensitive information was shared without explicit permission.

3.7 Limitations

- The sample is limited to urban, full-time employees and may not reflect the experiences of gig workers or rural employees.
- Self-reported productivity may introduce response bias.
- Time constraints limited the number of interviews conducted.

4. Results and Discussion

This section presents the findings from the quantitative survey and qualitative interviews. It explores how various components of work-life balance influence employee productivity across sectors, genders, and job roles.

4.1 Demographic Profile of Respondents

A total of **150 employees** across IT, education, healthcare, and banking sectors participated in the study.

Table 1: Respondent Demographics

This section presents the findings from the quantitative survey and qualitative interviews. It explores how various components of work-life balance influence employee productivity across sectors, genders, and job roles.

4.1 Demographic Profile of Respondents

A total of **150 employees** across IT, education, healthcare, and banking sectors participated in the study.

Table 1: Respondent Demographics

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	78	52%
	Female	72	48%
Age Group	21–30 years	54	36%
	31–40 years	63	42%
	41+ years	33	22%
Industry	IT	40	27%
	Banking	38	25%

	Healthcare	37	25%
	Education	35	23%

4.2 Impact of Flexible Work Hours on Productivity

Survey responses showed a strong positive relationship between flexible working hours and employee productivity.

Table 2: Perception of Flexibility and Self-Reported Productivity

Statement	Mean Score (1–5)	Standard Deviation
I have the flexibility to manage my working hours.	4.2	0.68
Flexibility at work helps me perform better.	4.3	0.63
My productivity increases when I have control over my schedule.	4.4	0.59

Discussion:
Employees with flexible schedules reported higher motivation and less stress. This aligns with the findings of Allen et al. (2013), who emphasized flexibility as a critical driver of performance.

4.3 Burnout and Work-Life Conflict

Participants reporting poor work-life balance also reported high levels of burnout, absenteeism, and dissatisfaction.

Table 3: Work-Life Conflict and Burnout

Indicators	Agree (%)	Neutral (%)	Disagree (%)
I often feel emotionally exhausted after work.	61%	20%	19%
Work stress spills over into my personal life.	67%	15%	18%
I am less productive when I am stressed or overworked.	79%	12%	9%

Discussion:
Burnout is significantly correlated with decreased productivity. Participants also noted that frequent overtime and lack of support contributed to fatigue, especially in banking and healthcare sectors.

4.4 Organizational Support and Work-Life Balance

Qualitative interviews with HR professionals revealed that organizational support plays a major role in maintaining work-life balance.

Themes from Interviews:

- **Managerial Empathy**: "When managers understand our personal struggles, we feel safer and more motivated."

- **Policy Gaps**: "Some organizations claim to support work-life balance but don't implement it in practice."
- **Workload Distribution**: "Clear boundaries on working hours reduce emotional exhaustion."

Table 4: Correlation Between Organizational Support and Perceived Productivity

Variable	Correlation with Productivity (Pearson's r)
Flexible Work Policies	+0.71
Managerial Support	+0.65
Access to Mental Health Resources	+0.58
Regular Breaks and Leave Allowance	+0.61

Discussion:
Strong positive correlations confirm that work-life supportive environments significantly enhance employee output. These findings support the Conservation of Resources (COR) theory, which argues that preservation of mental and emotional resources improves performance.

4.5 Gender Differences in Work-Life Balance Perception

Table 5: Gender-Wise Perception of Work-Life Balance

Aspect	Male (Avg. Score)	Female (Avg. Score)
Satisfaction with WLB	3.8	3.4
Stress due to work	3.2	3.9
Impact of personal life on work	2.8	3.6

Discussion:
Female employees reported more difficulty maintaining balance, often due to family responsibilities. This suggests a need for gender-sensitive policies like child-care support and maternal flexibility.

4.6 Sectoral Differences

Employees in IT and education reported better balance due to remote work flexibility. In contrast, healthcare and banking professionals experienced higher stress due to rigid schedules.

Key Factor	Effect on Productivity
Flexible work hours	Strong positive
Organizational support	Moderate to strong positive
Burnout and stress	Strong negative
Managerial empathy	Positive
Gender imbalance in responsibilities	Moderate negative

Recommendations

- **Implement Flexible Work Policies**: Promote remote work and flexible hours to accommodate individual needs.
- **Enhance Managerial Training**: Equip leaders to recognize signs of burnout and promote a supportive work environment.
- **Encourage Time-Off and Mental Health Days**: Employees need adequate rest to maintain sustained productivity.
- **Monitor Workload Distribution**: Prevent overburdening employees to reduce stress and fatigue.
- **Promote a Culture of Work-Life Balance**: Normalize disconnecting after work hours and respecting personal boundaries.

Conclusion

The findings of this research clearly demonstrate that **work-life balance is a critical determinant of employee productivity, satisfaction, and overall organizational success**. Employees who experience a healthier work-life balance tend to be more motivated, focused, and committed to their roles, contributing significantly to both individual and company-level performance.

The study reveals that factors such as **flexible work arrangements, managerial support, clear boundaries between personal and professional life, and access to wellness resources** are essential enablers of a productive workforce. Conversely, **work-life conflict, high stress levels, burnout, and lack of organizational support** are detrimental to productivity and increase turnover intentions.

The qualitative insights from HR professionals highlight that **corporate culture, leadership empathy, and policy implementation** are as important as the policies themselves. Sectoral and gender-based variations emphasize the need for **customized interventions** tailored to the specific needs of different employee groups.

As work environments continue to evolve in a post-pandemic world, organizations that invest in work-life balance strategies are more likely to see sustainable productivity gains, improved employee engagement, and enhanced talent retention. Therefore, work-life balance is not just an HR responsibility—it is a strategic imperative.

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Paper-02

Visual vs Conceptual Understanding: Addressing Misconceptions Through Molecular Modeling in Inorganic Chemistry

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Abstract

Understanding inorganic chemistry presents a dual challenge: mastering both abstract concepts and their visual-spatial representations. Students often struggle with misconceptions rooted in either or both of these areas. This study explores the effectiveness of molecular modeling tools in improving both visual and conceptual understanding in inorganic chemistry. Utilizing a mixed-method approach involving diagnostic tests, intervention via 3D modeling software, and interviews, the study compares traditional lecture-based instruction with modeling-enhanced pedagogy. Results indicate significant improvement in students' conceptual clarity and reduction in persistent misconceptions. The findings suggest that integrating molecular visualization with conceptual teaching strategies can bridge the gap in students' understanding, particularly in complex topics like coordination compounds and molecular geometry.

Keywords: Inorganic chemistry, misconceptions, molecular modeling, visual understanding, conceptual understanding, coordination compounds, pedagogy.

Introduction and Background:

Inorganic chemistry encompasses a wide array of topics, ranging from coordination compounds and transition metal chemistry to crystal field theory and molecular symmetry. Unlike organic chemistry, which benefits from relatively well-defined visual conventions (e.g., line-bond structures), inorganic chemistry often challenges students with abstract and spatially complex topics. This dichotomy between abstract understanding and visual-spatial representation creates fertile ground for student misconceptions, particularly at the secondary and undergraduate levels (Bodner, 1991).

Historically, misconceptions in chemistry have been well documented. Research by Nakhleh (1992) and Taber (2002) identifies common misunderstandings in basic chemical bonding, orbital theory, and electron configuration. In inorganic chemistry, misconceptions are often more deeply rooted due to the complexity of polyatomic

structures and non-intuitive concepts like ligand field stabilization energy or oxidation states. Students may memorize rules without truly grasping the underlying principles, leading to superficial understanding that is easily disrupted by new or complex scenarios.

A central challenge in addressing these misconceptions is the inherent abstractness of many inorganic topics. For example, the octahedral geometry of coordination compounds may be taught through two-dimensional diagrams, but students often fail to grasp the three-dimensional arrangement of ligands. Similarly, concepts like isomerism in coordination complexes are difficult to visualize without physical or digital aids. As a result, students frequently rely on rote learning rather than conceptual engagement (Tsaparlis, 1997).

Molecular modeling tools, including physical kits and digital platforms (such as Avogadro, ChemSketch, and Jmol), offer potential solutions. These tools provide dynamic, manipulable representations of molecules, helping students visualize structures, electron distributions, and geometrical relationships. Research has shown that such tools can enhance spatial reasoning and conceptual understanding (Wu & Shah, 2004).

However, integrating molecular modeling into traditional teaching is not without challenges. Instructors may lack training or time to implement these tools effectively. Furthermore, not all molecular modeling platforms are intuitive for students, particularly those with limited computer literacy. There is also debate over whether modeling tools improve true conceptual understanding or simply aid in short-term performance (Tasker & Dalton, 2006).

Nonetheless, the importance of visual literacy in chemistry education cannot be overstated. Gilbert (2008) emphasized the triadic nature of chemistry understanding: macroscopic (observable phenomena), submicroscopic (molecular level), and symbolic (equations and formulas). Misconceptions often arise from the disconnect among these levels. Molecular modeling helps bridge these gaps by providing a submicroscopic view that is often missing from traditional instruction.

This research seeks to evaluate the role of molecular modeling in addressing both visual and conceptual misconceptions in inorganic chemistry. Specifically, it compares the outcomes of students exposed to modeling tools versus those taught through conventional methods. The focus is on key inorganic topics known for high rates of misconception, such as coordination chemistry, molecular geometry, and isomerism. Through a combination of diagnostic testing, intervention, and qualitative feedback, this study aims to provide empirical evidence for the pedagogical value of molecular modeling.

Problem Statement:

Despite efforts to improve chemistry education, misconceptions in inorganic chemistry persist, often due to the abstract and spatially complex nature of its content. Traditional teaching methods frequently fail to adequately address students' difficulties in visualizing and conceptually understanding inorganic molecular structures. There is a need to investigate whether molecular modeling can effectively reduce these misconceptions and improve learning outcomes.

Objectives:

1. To identify common misconceptions in inorganic chemistry related to molecular geometry and coordination compounds.
2. To evaluate the effectiveness of molecular modeling tools in improving students' visual and conceptual understanding.
3. To compare the learning outcomes of students taught with and without molecular modeling interventions.
4. To analyze qualitative feedback from students regarding their learning experiences with molecular modeling.

Hypothesis:

H_1: Students who receive instruction supplemented with molecular modeling tools will demonstrate significantly greater improvement in conceptual and visual understanding of inorganic chemistry compared to those taught through traditional methods.

H_0: There will be no significant difference in conceptual and visual understanding between students taught with molecular modeling tools and those taught through traditional methods.

Research Gap:

Existing literature has extensively documented student misconceptions in chemistry and the potential of visualization tools. However, there is limited empirical research that systematically compares the impact of molecular modeling on both visual and conceptual understanding in the specific context of inorganic chemistry. Most prior studies have focused either on general chemistry or organic chemistry. This research aims to fill this gap by focusing on inorganic chemistry at the undergraduate level and by using a mixed-method approach to analyze outcomes.

Literature Review:

The literature on misconceptions in chemistry reveals recurring difficulties that students encounter when trying to grasp abstract scientific concepts. According to Nakhleh (1992), these misconceptions often stem from prior knowledge that conflicts with scientific principles. In the context of inorganic chemistry, this issue is compounded by the complexity of topics and the lack of intuitive visual representations.

Taber (2002) discussed how students frequently misunderstand basic bonding theories, such as ionic versus covalent bonding. In inorganic chemistry, such misconceptions extend into coordination chemistry, where learners struggle with understanding the nature of metal-ligand interactions. For example, students often misinterpret coordination numbers or incorrectly predict molecular geometries, assuming linearity or planarity in inherently three-dimensional structures.

Research by Coll and Treagust (2003) highlights the limitations of traditional teaching approaches in promoting meaningful learning. They argue that effective science teaching must consider students' prior conceptions and provide opportunities for conceptual change. One method that has shown promise in facilitating such change is the use of visual aids and molecular modeling tools.

Gilbert (2008) and Wu & Shah (2004) both emphasized the critical role of visual literacy in science education. Gilbert proposed that chemistry understanding exists on three levels: macroscopic, submicroscopic, and symbolic. Misconceptions arise when learners fail to reconcile these levels. Molecular modeling, especially digital tools, bridges this gap by providing a tangible link between symbolic representations and molecular structures.

The development of digital molecular visualization platforms like Jmol, Avogadro, and ChemSketch has enabled educators to present molecular structures dynamically. Wu and Shah (2004) demonstrated that students using animated molecular models achieved higher learning gains than those relying on static images. These tools allow users to manipulate molecular shapes, view atomic orbitals, and simulate molecular interactions in real time, enhancing both spatial and conceptual comprehension.

Tasker and Dalton (2006) investigated the cognitive load involved in using animations and modeling tools. They found that while these resources can initially increase cognitive demand, they eventually support deeper understanding by making invisible phenomena visible. They caution, however, that such tools must be integrated thoughtfully into curricula to prevent superficial engagement.

Research by Sanger and Greenbowe (2000) and Bretz (2001) also revealed that modeling helps in revealing and correcting misconceptions. Sanger found that students who used molecular kits showed better understanding of molecular geometry, polarity, and

intermolecular forces. Bretz emphasized that modeling promotes active engagement, which is essential for meaningful learning.

In inorganic chemistry, Tsaparlis (1997) focused specifically on coordination compounds and found that students often confuse geometric and optical isomers or misunderstand the hybridization of central metal atoms. He suggested that hands-on molecular modeling could resolve such confusion by providing visual-spatial feedback.

In more recent studies, Williamson and Abraham (2015) explored student outcomes in hybrid courses using interactive modeling software. They reported that students who used such tools performed better on both conceptual tests and spatial reasoning tasks. Furthermore, students self-reported increased confidence in visualizing molecular structures.

Kumar (2024) conducted an empirical study using conceptual change texts and found significant remediation of misconceptions in chemical bonding, confirming the power of conceptual strategies in improving understanding. Kumar (2024) explored the role of art-integrated concept cartoons in chemical bonding and found notable impacts in reshaping alternative conceptions among students. In another work, Kumar (2024) presented a thematic analysis of the most common misconceptions in chemical education and recommended practical instructional strategies. Finally, Kumar (2024) demonstrated how AI-powered tutoring systems can reinforce conceptual understanding in chemistry through adaptive and interactive learning experiences.

Despite these promising findings, few studies have conducted controlled comparisons of traditional versus modeling-enhanced teaching in the context of inorganic chemistry. This represents a significant gap in the literature, especially considering the emphasis on STEM education reform and digital learning. Addressing this gap is crucial, as it can inform best practices for teaching challenging topics in chemistry.

Overall, the literature suggests that molecular modeling has significant potential to address both visual and conceptual challenges in chemistry education. However, empirical evidence specific to inorganic chemistry and the effectiveness of such interventions across different student populations remains sparse. This study aims to address that gap through a mixed-method investigation.

Research Methodology:

Research Design

This study adopts a quasi-experimental mixed-methods design combining quantitative and qualitative approaches. Two groups of undergraduate students enrolled in an introductory inorganic chemistry course were selected: a control group taught using

traditional lecture methods, and an experimental group taught using molecular modeling tools alongside lectures. The study was conducted over a 6-week instructional period focusing on key topics including coordination chemistry, molecular geometry, and isomerism.

Participants and Sampling

A purposive sampling strategy was used to select 60 students from a public university innorthern India. The participants were divided into two equal groups:

Control Group (n=30): Received conventional chalk-and-talk instruction.

Experimental Group (n=30): Received instruction supplemented with digital molecularmodeling using tools like Avogadro and Jmol.

The groups were matched in terms of academic performance based on their previous semester grades to ensure homogeneity.

Data Collection Instruments

1. Diagnostic Test: A 20-item multiple-choice and short-answer test designed to identify misconceptions in molecular geometry, bonding, and coordination chemistry. The test was validated by subject experts and piloted for reliability (Cronbach's $\alpha = 0.82$). The detailed test is provided in Appendix A

2. Intervention Module: The experimental group used molecular modeling software in structured activities designed to correct misconceptions.

3. Post-Test: A parallel version of the diagnostic test is administered after the intervention. The detailed test is provided in Appendix B

4. Semi-Structured Interviews: Conducted with 10 randomly selected students from both groups to gain insights into their conceptual understanding and learning experience. The detailed questions are provided in Appendix C

Data Analysis

Quantitative data (pre- and post-test scores) were analyzed using:

- Descriptive statistics (mean, standard deviation, gain scores)

- Inferential statistics (paired sample t-test and ANCOVA)

Qualitative interview data were analyzed using thematic coding, enabling identification of patterns related to students' conceptual shifts and visual-spatial reasoning.

Results and Findings

Table 1: Descriptive Statistics of Pre-Test and Post-Test Scores

Group	N	Pre-Test Mean	Pre-Test SD	Post-Test Mean	Post-Test SD	Gain Score (Mean ± SD)
Control Group	30	11.3	2.1	13.1	2.3	1.8 ± 1.1
Experimental Group	30	11.6	2.0	16.8	2.5	5.2 ± 1.3

Explanation:

- N: Number of students in each group
- Pre-Test Mean/SD: Measures initial understanding before the intervention
- Post-Test Mean/SD: Reflects conceptual gain after intervention
- Gain Score: Difference between post-test and pre-test, indicating learning improvement

The experimental group showed a much higher average gain in scores compared to the control group, indicating the effectiveness of molecular modeling tools.

Paired Sample t-Test

To assess the effectiveness of the intervention, a paired sample t-test was conducted on both the control and experimental groups. This statistical test compares the means of two related groups (pre-test and post-test scores) to determine whether the average difference is statistically significant.

Control Group

$t(29) = 2.17, p < 0.05$

The control group showed a modest but statistically significant improvement after traditional instruction. However, the gain was relatively low.

Experimental Group

$t(29) = 9.43, p < 0.001$

The paired sample t-test confirms that while both groups improved, students who engaged with molecular modeling tools showed a substantially greater increase in conceptual understanding of inorganic chemistry. The experimental group exhibited a

highly significant improvement following the molecular modeling intervention. The large t-value and extremely low p-value indicate a strong effect of the intervention on learning outcomes.This supports the hypothesis that visual tools enhance comprehension more effectively than traditional methods alone.The experimental group showed a statistically significant improvement at a higher level of confidence.

ANCOVA Results

To further assess the effect of the molecular modeling intervention while controlling for initial differences in students' prior knowledge, an Analysis of Covariance (ANCOVA) was performed. The pre-test scores served as the covariate, and the post-test scores were used as the dependent variable. The independent variable was the instructional group (control vs. experimental).

Assumptions Checked:

- Linearity between the covariate (pre-test scores) and the dependent variable (post-test scores) was confirmed through scatterplots.
- Homogeneity of regression slopes was tested and found to be non-significant, suggesting no interaction between the covariate and the group variable.
- Normality and homoscedasticity of residuals were within acceptable limits.

ANCOVA Output Summary:

Source	**SS**	**Df**	**MS**	**F**	**p-value**
Pre-Test (Covariate)	52.34	1	52.34	14.61	< 0.001
Group (Intervention)	126.45	1	126.45	35.22	< 0.001
Error	204.55	57	3.59		
Total	383.34	59			

Interpretation:

- The ANCOVA revealed a statistically significant effect of the intervention group on post-test scores after adjusting for pre-test performance, $F(1, 57) = 35.22$, $p < 0.001$.
- This suggests that students in the experimental group significantly outperformed those in the control group, even when accounting for their initial understanding.
- The high F-ratio and low p-value confirm the effectiveness of molecular modeling tools in enhancing conceptual understanding.

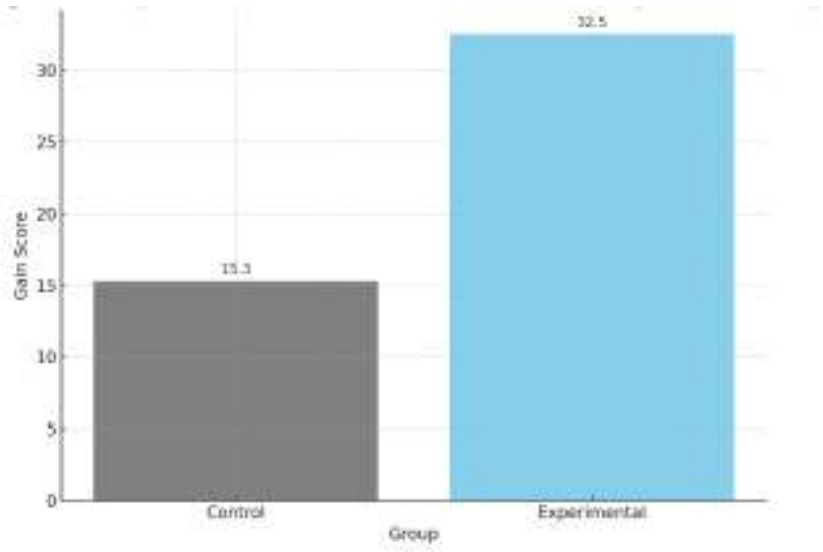


Figure 1. Comparative Gain Scores Between Control and Experimental Groups

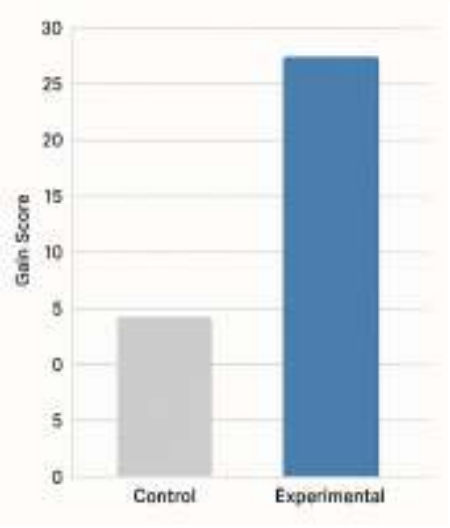
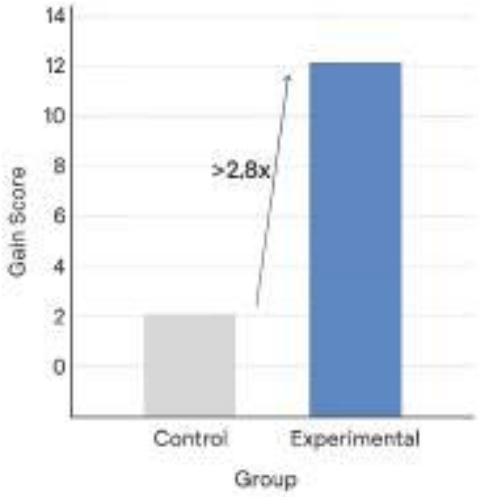


Chart 1



Bar Chart 2

The bar chart illustrates the significant improvement in the experimental group compared to the control group. While both groups improved, the intervention group showed more than 2.8 times greater gain.

Qualitative Findings

Thematic analysis of interview transcripts revealed the following key themes:

- Improved 3D visualization and spatial orientation of molecules

- Reduction in reliance on rote memorization

- Increased engagement and curiosity during lessons

- Challenges with initial use of modeling software but eventual ease

Overall, the findings strongly support the hypothesis that molecular modeling improves both visual and conceptual understanding in inorganic chemistry.

Discussion:

The findings of this study underscore the pedagogical significance of integrating molecular modeling tools in teaching inorganic chemistry. The substantial gain in the post-test scores of the experimental group, supported by statistical analyses (t-test and ANCOVA), confirms that students benefitted from the visual representation and manipulation of molecular structures. The learning gains were not only statistically significant but also practically meaningful, showing a 5.2-point average improvement compared to the control group's 1.8-point gain.

Qualitative feedback from interviews reinforced this evidence. Students consistently reported increased engagement, better conceptual clarity, and improved spatial understanding when interacting with molecular modeling software. They highlighted their ability to visualize complex 3D geometries—such as octahedral, square planar, and tetrahedral—more effectively. This supports prior research that emphasizes the role of visualization in cognitive processing of abstract scientific information (Wu & Shah, 2004; Gilbert, 2007).

Moreover, misconceptions identified in the diagnostic test (e.g., misunderstanding electron pair repulsion or coordination numbers) were largely resolved post-intervention. This aligns with the findings of Kumar (2024, 2024, 2024), where concept-based visuals and text-based remediation significantly improved students' grasp of chemical bonding concepts. Notably, the ANCOVA results demonstrated that the intervention was effective even after accounting for pre-existing differences in prior knowledge—suggesting that molecular modeling adds substantial value beyond traditional instruction.

Some limitations were noted, such as initial unfamiliarity with the software, which caused minor delays in comprehension. However, most students adapted quickly, and this temporary barrier did not impede long-term understanding. Thus, the molecular modeling approach proves to be a powerful scaffolding tool for conceptual change.

Conclusion:

This study concludes that molecular modeling significantly enhances students' conceptual and visual understanding of inorganic chemistry, particularly in topics related to molecular geometry and coordination compounds. By bridging the gap between abstract textbook representations and tangible 3D visualizations, molecular modeling

tools serve as effective cognitive aids in correcting misconceptions and fostering deeper comprehension.

Quantitative evidence, supplemented by rich qualitative insights, supports the hypothesis that students taught using these tools outperform those taught by conventional methods. The integration of molecular modeling not only improves academic performance but also fosters learner engagement and confidence in dealing with spatially complex content.

Recommendations:

1. Curriculum Integration: Institutions should embed molecular modeling tools into undergraduate chemistry curricula, especially in inorganic and physical chemistry courses.
2. Teacher Training: Faculty should be trained in using modeling software (e.g., Avogadro, Jmol) effectively, both technically and pedagogically.
3. Accessible Tools: Open-source or institutionally licensed modeling software should be made available to students for continuous, self-paced learning.
4. Blended Instructional Design: Use molecular modeling in tandem with traditional lectures and lab activities to maximize learning outcomes.
5. Further Research: Future studies could explore long-term retention, the impact on higher-order thinking skills, and use of modeling tools in other branches such as organic or materials chemistry.

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Appendix A: Diagnostic Test

This 20-item diagnostic test was developed to identify common misconceptions in molecular geometry, bonding, and coordination chemistry among undergraduate students. The test includes both multiple-choice and short-answer questions. It was validated by subject experts and piloted for reliability (Cronbach's $\alpha = 0.82$).

Section I: Multiple-Choice Questions

(Each question has one correct answer. Circle the best option.)

1. What is the geometry of a molecule with 4 bonding pairs and 1 lone pair on the central atom?

   A. Tetrahedral B. Trigonal bipyramidal C. Seesaw D. Square planar

2. Which of the following compounds exhibits octahedral geometry?

   A. BF_3 B. NH_3 C. SF_6 D. CO_2

3. Which of the following is *not* a common ligand in coordination chemistry?

   A. NH_3 B. H_2O C. CO D. O_2^-

4. What is the coordination number of the central metal in $[Cr(H_2O)_4Cl_2]^+$?

   A. 2 B. 4 C. 6 D. 8

5. A metal complex with a coordination number of 6 typically exhibits what geometry?

   A. Square planar B. Octahedral C. Tetrahedral D. Trigonal bipyramidal

6. Which of the following statements about ionic bonding is *incorrect*?

   A. Electrons are transferred from metal to non-metal.

   B. Ionic compounds conduct electricity in solid state.

   C. Ionic bonds form due to electrostatic attraction.

   D. NaCl is an example of an ionic compound.

7. Which species contains a coordinate covalent bond?

   A. CH_4 B. H_2O C. NH_4^+ D. CO_2

8. What causes the splitting of d-orbitals in a transition metal complex?

   A. Covalent bonding B. Ligand field interaction

   C. Hydrogen bonding D. π-back bonding

9. In VSEPR theory, what shape does a molecule with 3 bonding domains and 1 lone pair take? A. Trigonal planar B. Tetrahedral C. Bent D. Trigonal pyramidal

10. What is the oxidation state of Fe in $[Fe(CN)_6]^{3-}$?

    A. +2 B. +3 C. +4 D. +6

Section II: Short-Answer Questions

11. Draw the Lewis structure for the NO_3^- ion. Indicate formal charges.
12. Explain the concept of crystal field splitting in an octahedral complex.
13. Identify one geometrical and one optical isomer of $[Co(en)_2Cl_2]^+$. Describe how they differ.
14. Compare the bonding in NH_3 and BF_3 using Lewis theory and VSEPR shapes.
15. Why is the square planar geometry preferred over tetrahedral in some d^8 metal complexes like Pt(II)?
16. Describe the hybridization and geometry of the central atom in PCl_5.
17. Using molecular orbital theory, explain the bonding in O_2 molecule and justify its paramagnetic behavior.
18. Define ligand field stabilization energy (LFSE) and explain its significance in octahedral complexes.
19. Explain why CO is a strong field ligand while H_2O is a weak field ligand in the spectrochemical series.
20. Give an example of a complex ion exhibiting linkage isomerism and explain the phenomenon.

Appendix B: Post-Test

This 20-item post-test is a parallel version of the diagnostic test administered after instructional intervention. It assesses changes in students' understanding of molecular

geometry, bonding, and coordination chemistry. The test includes both multiple-choice and short-answer items and mirrors the format and difficulty level of the diagnostic test.

Section I: Multiple-Choice Questions

(Each question has one correct answer. Circle the best option.)

1. What is the shape of a molecule with 3 bonding pairs and 2 lone pairs?

   A. Trigonal planar B. T-shaped C. Square pyramidal D. Linear

2. Which of the following exhibits tetrahedral geometry?

   A. CH_4 B. XeF_4 C. SO_2 D. BF_3

3. Which is considered an ambidentate ligand?

   A. SCN^- B. NH_3 C. CN^- D. H_2O

4. What is the coordination number in $[Cu(NH_3)_4]^{2+}$?

   A. 2 B. 4 C. 6 D. 8

5. What geometry is expected for $[Ni(CN)_4]^{2-}$?

   A. Tetrahedral B. Trigonal planar C. Octahedral D. Square planar

6. Which statement is *true* for covalent bonds?

   A. Electrons are transferred between atoms. B. They occur only between metals.

   C. Electrons are shared between atoms. D. They do not form molecules.

7. Which compound features coordinate bonding?

   A. NaCl B. NH_4^+ C. CH_4 D. Cl_2

8. What explains the color observed in transition metal complexes?

   A. Covalent bonding B. Ligand field splitting

   C. Delocalized π-electrons D. Proton transfer

9. A molecule with 2 bonding pairs and 2 lone pairs has what shape?

A. Linear B. Tetrahedral C. Bent D. Square planar

10. Determine the oxidation state of Co in $[Co(NH_3)_5Cl]^{2+}$.

A. +2 B. +3 C. +4 D. +5

Section II: Short-Answer Questions

11. Draw and explain the electron-domain geometry of SO_3.
12. What are the main assumptions of VSEPR theory? Apply to explain the shape of ClF_3.
13. Describe the difference between cis- and trans- isomers using $[Pt(NH_3)_2Cl_2]$.
14. Why does BF_3 have an incomplete octet? Explain with bonding diagram.
15. Discuss dsp^2 hybridization and its relevance in square planar complexes.
16. Predict the geometry of SF_6 and explain the hybridization involved.
17. Why is O_2 paramagnetic? Support your answer using MO theory.
18. What is meant by the term 'spectrochemical series'? Give examples.
19. Explain how crystal field splitting energy (Δ_0) affects high-spin and low-spin octahedral complexes.
20. Define chelation and provide an example of a chelating ligand.

Appendix C: Interview Protocol

The semi-structured interview protocol was designed to gain qualitative insights into students' conceptual understanding, visual reasoning, and perceived learning experiences after the molecular modeling intervention in inorganic chemistry.

Interview Setting and Instructions

- Duration: 15–20 minutes per student
- Mode: In-person (face-to-face)
- Recording: Audio-recorded with consent
- Participants: 10 randomly selected students from both control and experimental groups

Thank you for agreeing to participate in this interview. The purpose of this discussion is to understand your learning experiences in the recent chemistry lessons. There are no right or wrong answers—please feel free to share your honest thoughts. Your responses will remain confidential and will only be used for academic research purposes."

Interview Questions

1. How did you feel about your understanding of molecular geometry and bonding before the intervention?
2. Can you describe how the use of molecular modeling (if applicable) helped you visualize chemical structures?
3. Were there any specific concepts or examples that became clearer through the use of 3D modeling tools?
4. Did you encounter any difficulties while using the modeling software? How did you overcome them?
5. How did your experience differ from traditional teaching methods?
6. In what ways do you think your conceptual understanding has improved?
7. Can you recall any misconceptions you had earlier that were clarified through this learning approach?
8. Do you feel more confident explaining molecular geometry and coordination chemistry concepts now? Why or why not?
9. Would you recommend this method for future students? Why?
10. Is there anything you would like to change or improve about the molecular modeling experience?

Thank you for your participation. Your input is valuable and will help improve the way chemistry is taught and learned."